DOCUMENT RESUME

ED 082 270 EA 004 453

AUTHOR	Bruno, James E.; Fox, James N.
TITLE	Quantitative Analysis in Educational Administrator Preparation Programs. ERIC/CEM State-of-the-Knowledge Series Number Nineteen. UCEA Monograph Series Number Six.
INSTITUTION	Oregon Univ., Eugene. ERIC Clearinghouse on Educational Management.; University Council for Educational Administration, Columbus, Ohio.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	73
CONTRACT	OEC-0-8-080353-3514
NOTE	89p.
AVAILABLE FROM	University Council for Educational Administration, 29 West Woodruff Avenue, Columbus, Ohio 43210 ($2.00, Quantity Discounts)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Administrator Education; Cost Effectiveness; Decision Making; Educational Accountability; Educational Administration; *Management Development; Management Information Systems; Operations Research; Problem Solving; *Program Content; Program Development; *Program Evaluation; *Statistical Analysis; Systems Analysis
IDENTIFIERS	*Quantitative Analysis

ABSTRACT

The demand for administrators and specialists trained in quantitative concepts and skills has increased across the last decade mainly as a result of the accountability movement. Quantitative methods can greatly assist the school administrator in certain decisionmaking processes, although it is essential that he be able to distinguish between those decisions that readily lend themselves to quantitative methods and those that do not. In this monograph, the authors discuss the emerging trend toward the integration of quantitative analysis into the preparation of school administrators. They outline the potential benefits of and the problems associated with the application of such concepts and skills to school administration. The authors present the ideal content of preparation programs in quantitative analysis for general administrators, practicing specialists, and research specialists; and they evaluate both university and nonuniversity programs already in practice. A comprehensive bibliography on quantitative analysis in education is included, as well as brief descriptions of various programs in the field. (Editors)

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Quantitative Analysis in Educational Administrator Preparation Programs

James E. Bruno and James N. Fox

1973

EA 00 1 453

Commissioned by
ERIC Clearinghouse on
Educational Management

Published by
University Council for
Educational Administration

ERIC/CEM–UCEA SERIES ON
ADMINISTRATOR PREPARATION

Under the editorship of

PHILIP K. PIELE, Director

ERIC Clearinghouse
on Educational Management
University of Oregon

and

JACK CULBERTSON, Executive Director
University Council
for Educational Administration
The Ohio State University

The ERIC Clearinghouse on Educational Management operates under contract with the National Institute of Education of the United States Department of Health, Education, and Welfare. This publication was prepared pursuant to that contract. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official National Institute of Education position or policy.

Library of Congress Catalog Number: 72-86752
ERIC/CEM Accession Number: EA 004 453

ERIC/CEM State-of-the-Knowledge Series, Number Nineteen
UCEA Monograph Series, Number Six

Manuscript edited by Ian Templeton and Dee Schofield

Printed in the United States of America
Interstate Printers and Publishers, Inc.
19 North Jackson
Danville, Illinois 61832

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The mission of the University Council for Educational Administration is to improve the preparation of administrative personnel in education. Its membership consists of major universities in the United States and Canada. UCEA's central staff works with and through scholars in member universities to create new standards and practices in administrator preparation and to disseminate the results to interested institutions.

UCEA's interest in the professional preparation of educational administrators includes both continuing education and resident, preservice programs. Interinstitutional cooperation and communication are basic tools used in development activities; both administrators and professors participate in projects.

The Council's efforts currently are divided into six areas: developing and testing strategies for improving administrative and leadership practices in school systems; encouraging an effective flow of leaders into preparatory programs and posts of educational administration; advancing research and its dissemination; providing information and ideas helpful to those in universities responsible for designing preparatory programs; integrating and improving preparatory programs in specific areas of administration; and developing and evaluating the Monroe City URBSIM simulation and support materials.

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Foreword

During the last decade, programs to prepare educational administrators have undergone considerable change. Growing specialization in the field of educational administration resulting from new knowledge production (for example, operations research) is one reason for the program change. Another is the continuing search for more effective patterns of field experience, instructional method, and content in preparatory programs.

Because of the varied changes achieved in preparation in different universities, those interested in designing or updating programs today are faced with a greater number of options than was the case ten years ago. A major purpose of this monograph series is to shed light on the various options now available to those interested in administrator preparation. A second purpose is to advance general understanding of developments in preparation during the past decade. The series is directed to professors, students, and administrators interested in acquiring information on various aspects of preparation.

Each author in the series has been asked to define the parameters of his subject, review and analyze recent pertinent literature and research, describe promising new practices emerging in actual training programs across the country, and identify knowledge gaps and project future developments. The papers in the series were planned and developed cooperatively by the ERIC Clearinghouse on Educational Management and the University Council for Educational Administration. The editors of the series hope that the monographs will prove valuable to those interested in understanding and assessing recent and projected developments in preparation.

In this monograph, the sixth in the series, James E. Bruno and James N. Fox discuss the emerging trend toward the integration of quantitative analysis into the preparation of school administrators. Citing several rationales for the use of quantitative analysis in education, the authors then outline the potential benefits and problems of its use. They also describe the ideal content of preparation programs in quantitative analysis for general administrators, specialists, and researchers, and evaluate both university and nonuniversity programs already in practice.

Dr. Bruno is an associate professor of education in the Graduate School of Education at the University of California at Los Angeles. Specializing in the economics of education and the application of systems analysis to problems in educational planning, Dr. Bruno has extensive experience as a teacher, researcher, consultant, and author. He received his bachelor's degree in 1963, his master's degree in 1965, and his doctor's degree in 1968, all from UCLA.

Mr. Fox is working toward a doctor's degree in educational planning and finance in the Graduate School of Education at UCLA. He is also serving as a postgraduate researcher in the School Governance Project at the University of California at Berkeley. He received his bachelor's degree from Stanford University in 1964 and his master's degree in 1968 from UCLA.

PHILIP K. PIELE
JACK CULBERTSON

1

Introduction

The environment facing today's educational administrators is far different from that faced by their predecessors. No longer can educational leaders be preoccupied solely with the pursuit of excellence and the maintenance of minimum standards (James 1969). Today's administrators face an environment replete with new pressure and new promise.

The pressure emanates from several sources including tired taxpayers, militant minorities, suspicious citizens ("PPBS and sex education are communist plots"), and parsimonious politicians (Thompson 1971 and James 1969). These groups are often the source of new demands placed on educational leaders, including demands for accountability, equality, and justification of programs. Furthermore, as decision-making at the school site supplants central office direction, additional pressure is placed on the school administrator.

The promise lies in technological advance. More precise tools and techniques, initially developed in economics and the management

sciences, are now available to educational administrators (Hartley 1967). These new decision-making aids include computer technology and such methods as operations research (OR), operations analysis, cost-effectiveness analysis, cost-benefit analysis, systems analysis, systems approach, policy analysis, planning-programming-budgeting systems (PPBS), and planning-programming-budgeting-evaluation systems (PPBES). All these tools and techniques have a common goal—the quantification of information for decision-making. For this reason the techniques are grouped under the generic term "quantitative analysis."

This introductory chapter defines the terminology that will be used throughout the paper. Chapter 2 reviews literature concerning the development of interest in the application of quantitative analysis to educational administration. The chapter also discusses rationales for incorporating the tools and techniques of quantitative analysis in the curricula of educational administrators. Problems involved in the application of quantitative analysis to educational administration are also noted. Chapter 3 discusses the ideal content of preparation programs and the specialized training necessary for administrators, specialists, and researchers. Chapter 4 outlines several programs already in practice incorporating quantitative analysis into their curricula. The role the tools and techniques of quantitative analysis may play in the future of educational administration is considered in chapter 5.

This monograph does not focus on specific applications of quantitative analysis to educational problems.* Instead it reviews, synthesizes, and analyzes current thought and practice relevant to the inclusion of quantitative analysis in preparation programs for educational administrators.

TERMINOLOGY

Listed below are several contrasts that define the components of quantitative analysis. The first contrast deals with operations research, systems analysis, and policy analysis. The primary difference between these three is in terms of comprehensiveness and

*Readers interested in specific applications are referred to the bibliographies by McNamara (1971), Alkin and Bruno (1970), Hinds (1969), and the Organisation for Economic Cooperation and Development (1969b).

degree of precision associated with each. Cost-effectiveness analysis and cost-benefit analysis compose the second contrast. These two are similar except for the manner in which they treat outputs. The definition of the final pair, PPBS and PPBES, notes that the two are identical except that the latter places explicit emphasis on the evaluating stage of the procedure.

OPERATIONS RESEARCH, SYSTEMS ANALYSIS, POLICY ANALYSIS

The primary difference between operations research, systems analysis, and policy analysis lies in the scope of each. Operations research techniques typically attack well-defined problems with well-defined objectives and seek to obtain either maximum output with given resources or a given level of output at a minimum expenditure of resources. Systems analysis (here used synonymously with "systems approach") is more global in its approach. Its tasks include structuring the problem, examining and reexamining objectives, and specifiyng the costs and effects of alternative routes to objectives or goals.

The contrast between operations research and systems analysis has been well explicated by Enthoven.

> Generally speaking, operations research accepts specified objectives and given assumptions about the circumstances, the hardware, and the like, and then attempts to compute an optimum solution, usually maximizing some objective, given the available resources. Operations research attempts to do an optimization in the small. It may be necessary for the operations researcher first to define the problem, but the operations research techniques themselves are intended for the solution of well defined problems, that is, problems in which all of the relevant relationships can be specified. Operations research then attempts to select an optimum solution from a predetermined range of alternatives.
>
> Systems analysis, on the other hand, has a broader orientation. It analyzes alternative objectives and explores their implications. It is focused more on exploring the implications of a single set of assumptions. Systems analysis ordinarily is not concerned with computing an optimum solution. If there is optimization involved, it is optimization in the large, rather than in the small. Systems analysis is concerned with avoiding gross error and with giving the decision-maker a range of choices representing different mixes of effectiveness and cost so that he can make his choice. It is part of systems analysis to question the objectives. (1968, p. 285)

Policy analysis, as Wildavsky has noted, "is similar to a broadly conceived version of systems analysis" (1969, p. 190). Dror has

pointed out the boundaries that separate policy analysis from systems analysis and operations research. In policy analysis,

1. Much attention would be paid to the political aspects of public decision-making and public policy-making (instead of ignoring or condescendingly regarding political aspects). . . .
2. A broad conception of decision-making and policy-making would be involved (instead of viewing all decision-making as mainly a resource allocation). . . .
3. A main emphasis would be on creativity and search for new policy alternatives, with explicit attention to encouragement of innovative thinking. . . .
4. There would be extensive reliance on . . . qualitative methods.
5. There would be more emphasis on futuristic thinking. . . .
6. The approach would be looser and less rigid, but nevertheless systematic, one which would recognize the complexity of means-ends interdependence, the multiplicity of relevant criteria of decision, and the partial and tentative nature of every analysis. . . . (Dror 1967, pp. 200-201)

COST-EFFECTIVENESS ANALYSIS AND COST-BENEFIT ANALYSIS

Hovey notes that cost-effectiveness analysis and cost-benefit analysis are very similar. The main difference between the two lies in the manner in which outputs are measured. In cost-effectiveness analysis outputs are expressed in "raw" units, while in cost-benefit analysis the outputs are assigned a dollar value.

> Cost-benefit analysis, like cost-effectiveness analysis, involves attaching to models values or prices that reflect the impact of program inputs on valued outputs. In cost-effectiveness, the input side is translated into dollars, while the output side is left in non-dollar units (deaths prevented, children educated, families housed, etc.). In cost-benefit analysis, both the inputs and the outputs are given dollar valuations. Because both inputs and outputs are measured in the same dimension, cost-benefit analysis by its nature is a system for recommending program decisions. It does not necessarily eliminate the political value judgments necessary to translate cost-effectiveness studies into decision. Instead, it incorporates those value judgments into the analytical criteria, thereby making the result a single simple answer. The end result of cost-benefit analysis is a determination that the benefits are (a) greater than, (b) equal to, or (c) less than the costs. (Hovey 1968, pp. 55-56)

PPBS AND PPBES

A planning-programming-budgeting system (PPBS) for education

can be defined in terms of five major components: goals, objectives, programs, budgets, and evaluations.

> A *goal* is a statement of broad direction, purpose, or intent that is general and not concerned with particular achievements within a specified time frame.
>
> An *objective* is a measurable desired accomplishment whose attainment within a given time frame and under specifiable conditions can be evaluated. The attainment of the objective advances the system toward corresponding goals.
>
> A *program* is a group of interdependent, closely related activities or services contributing to or progressing toward a common objective or set of similar objectives.
>
> The *program budget* is a plan that relates proposed expenditures for programs to goals and objectives within a specific time frame, based upon a program structure classification. It includes the proposed revenue source for financing programs.
>
> *Program evaluation* is the systematic assessment of program information to ascertain the degree to which established program objectives have been accomplished. (Peat, Marwick, Mitchell, and Co., 1972, pp. II-4, II-6, II-9, II-10, and II-11)

Figure 1 illustrates the interaction between these five elements.

A planning-programming-budgeting-evaluation system (PPBES) is identical to PPBS. However, by referring to it as PPBES, the evaluation element is explicitly identified.

Similarities and Differences

We have noted that all the tools and techniques of quantitative analysis share a common goal—the quantification of information for decision-making. Additional unifying factors are discussed below. Wright indicates that systems analysis must possess the three essential characteristics of the scientific method: "internal logical consistency, explicitness, and objectivity" (1969, p. 29). This statement can be extended to include all the tools and techniques of quantitative analysis as well.

In a similar vein, qualities attributed to "systematic analysis" (Schultze 1969) pertain to quantitative analysis in general. All the elements of quantitative analysis strive to

- separate relevant from irrelevant issues
- identify the specific assumptions and factual bases upon which alternative recommendations rest
- trace out the knowable consequences and costs of each alternative (Schultze 1969, p. 6)

FIGURE 1

RELATIONSHIP OF PPBS ELEMENTS

Source: Peat, Marwick, Mitchell, and Co., 1972, p. II-2.

By these means, quantitative analysis in general, like Schultze's "systematic analysis," is designed to distinguish between subjective judgments and verifiable facts (p. 6).

It is important to understand the differences between the various tools and techniques of quantitative analysis. The primary difference is that certain tools and techniques are suitable for some tasks, whereas others are more appropriate for different tasks. Table 1 illustrates the different types of tasks that might be handled by educational quantitative analysis. The polar extremes of the types of tasks are labeled tactical problems and policy problems. Tactical problems include areas such as school bus routing, repair-replace and maintenance decisions regarding equipment, and student scheduling. At the other end of the continuum, under policy

problems, are listed wage and salary negotiations, integration policies, and curriculum issues.

The tools and techniques of operations research are well adapted to solving tactical problems; policy problems require a different set of tools. Expectations must be adjusted according to the type of problem under consideration. The precision associated with the solution of tactical problems must not be demanded when attacking policy problems. Such a demand will lead to unwarranted expectations that, in turn, will lead to disappointment. On the other hand, if tactical problems are considered identical to policy problems, the full potential of the appropriate tools and techniques of quantitative analysis will not be tapped.

TABLE 1
TYPES OF PROBLEMS HANDLED BY QUANTITATIVE ANALYSIS

Tactical Problems	*Policy Problems*
Typical Tasks	*Typical Tasks*
School Bus Routing Repair-Replace Decisions Student Scheduling	Wage and Salary Negotiations Integration Policies Curriculum Issues
Objectives, Constraints, and Criteria Predetermined	Objectives, Constraints, and Criteria Subject to Challenge
Concerned with the Question—How?	Concerned with the Questions—What? and Why?
Typical Tools	*Typical Tools*
Operations Research, Operations Analysis, Cost-Effectiveness Analysis, Cost-Benefit Analysis	Cost-Effectiveness Analysis, Cost-Benefit Analysis, PPBS, PPBES, Systems Analysis, Policy Analysis
Mathematical Orientation	Social Science and Philosophical Orientation
Technician Plays a Major Role	Technician Plays a Supportive Role

2

History and Rationales

The first portion of this chapter is a review of literature that briefly documents the emerging interest of international, federal, and professional organizations in quantitative analysis within the field of educational administration. The second part discusses the potential benefits of quantitative analysis to the schools as well as the rationales for incorporating this kind of analysis in school administration curricula. Discussion focuses on the preparation of general administrators and specialists whose knowledge of the tools and techniques of quantitative analysis can assist the schools in planning and decision-making. The chapter concludes with a discussion of problems encountered in the application of quantitative analysis to educational administration.

Emerging Interest in Quantitative Analysis

Quantitative analysis is by no means a new concept in educational administration. As early as 1909, Ayres published his "Index of

Efficiency." As Callahan says about Ayres, "He was one of the first educators to picture the schools as a factory and to apply the business and industrial values and practices in a systematic way" (1962, pp. 15-16). Business and industrial practices in this era were basically quantitatively oriented. Ayres suggested bringing this quantitative orientation into the administration of schools.

More recent interest in the application of quantitative tools and techniques to educational administration has been demonstrated on international, federal, and professional levels. International interest is illustrated by two symposia sponsored by the Committee for Scientific and Technical Personnel of the Organisation for Economic Cooperation and Development (OECD). The first symposium, held in 1967, dealt mainly with the efficient use of resources at the individual institution and local school system levels (OECD 1969a). The second, held in April 1968, addressed broader issues such as budgeting, cost-benefit analysis, and cost-effectiveness analysis in educational administration (OECD 1968).

Federal interest has been evidenced by the formation of the Division of Operations Analysis (DOA) in the National Center for Educational Statistics (NCES) and by DOA's subsequent sponsorship in 1967 of a symposium—Operations Analysis of Education. About 1,100 educators, statisticians, mathematicians, economists, representatives of related sciences, and observers from foreign countries attended the symposium. This is believed to be the first nationwide conference devoted exclusively to operations research in education (Stoller 1969).

The symposium had a dual purpose: to provide opportunity both for information exchange among educ tors, educational researchers, and educational operations analysts, and for communication of specialized material among the analysts. To ensure a varied program, sessions were held on school management, college and university systems, national educational systems, achievement analysis, cost-benefit analysis, PPBS, educational economics, and model building. The speakers included school administrators, university teachers, technical consultants, and government employees.*

Professional interest in quantitative analysis is indicated by the American Association of School Administrators' (AASA) special

*Stoller and Dorfman edited the proceedings for publication in the April 1969 issue of *Socio-Economic Planning Sciences* (An International Journal).

Commission on Administrative Technology. The commission, created in 1966, was

> . . . charged with the responsibility of identifying new approaches in management of other fields that can be adapted to school administration. The Commission includes a mix of practitioners, that is, superintendents, as well as professors concerned with the preparation of future practitioners. . . . It is concerned and impressed with the possibilities of applying the systems approach to school administration. (Knezevich 1969a, p. 131)

The commission published its report in 1969.

Knezevich observes that AASA does not appear content with a commission report alone but

> . . . is seriously contemplating launching a new and exciting vehicle for the continuing professional development of practicing school administrators. It is presently designated as the National Academy for School Executives. Within its program may be a series of seminars, workshops, and clinics concerned with developing systems capability among school administrators. (1969a, p. 132)

The University Council for Educational Administration (UCEA) also demonstrated interest in quantitative analysis when it sponsored, early in 1966, "one of the first multi-institutional seminars devoted to the use of systems analysis in education" (Hartley 1968, p. 63). The seminar was attended by professors from twenty major universities who met to study the relevancy of systems procedures for education (Davis and Hendrix 1966). Hartley (1968) believes that the significance of this task-force seminar lay not so much in its immediate productive value as in its proposals for further steps to be taken (p. 63).

A few years ago the Division of Administrative Studies of the American Educational Research Association (AERA) entered the field and has, at its annual conventions, sponsored symposia on the application of quantitative analysis to educational administration. The 1970, 1971, and 1972 symposia titles were, respectively, "Application of Quantitative Techniques to School District Decision-Making," "Operations Research–Systems Analysis in School District Planning," and "Educational Operations Research."

Further interest in preparing educational administrators in the use of quantitative analysis is illustrated by the recent emergence of texts such as those by Hartley (1968), Banghart (1969), Tanner (1971), Thomas (1971), Thompson (1971), Van Dusseldorp

and others (1971), Van Gigch and Hill (1971), Kaufman (1972), and Coombs and Hallak (1972). Additional publications in this area include a recent special issue of *Educational Technology* edited by Kraft and Latta (1972), as well as materials prepared by both the San Mateo County Board of Education and the Center for the Advanced Study of Educational Administration (CASEA). The publications of these latter two organizations are described in some detail in chapter 4.

RATIONALES

The potential benefits to the schools are the major rationale for incorporating quantitative analysis into the curricula of educational administrators, as well as for training specialists to serve school districts.

The educational administrator stands to benefit greatly from a thorough acquaintance with quantitative methods. Such methods and skills can assist him in his new role of managerial decision-maker. By providing the administrator with reliable information, quantitative analysis can enhance his important decision-making abilities, thus strengthening his administrative stance. Knowledge of quantitative analysis can also assist the administrator in keeping up with the literature in his field and, hence, in being apprised of important developments.

The specialist in quantitative analysis can assist the school administrator in decision-making and planning. Part of the quantitative analyst's role is to help the district to define problems and to ask relevant questions concerning planning and evaluation. His information can be made available to the community, to the school board, and to political action groups, as well as to the administrator. He can also outline the future implications of proposed plans. His efficacy in the administrative process, however, is contingent on the ability of the decision-maker (the general administrator) to understand and utilize the data from quantitative analysis.

THE CHANGING ROLE OF THE SCHOOL ADMINISTRATOR

The role of the American public school administrator has changed drastically over the last decade. The administrator who rose from the teaching ranks and believed in the unity of the teacher-administrator professional team philosophy is being

supplanted by a more management- or decision-oriented individual. It is a moot point whether the school administrator desired this managerial function, whether he was forced by societal demands for accountability to assume it, or whether the development of managerial skills was used to maintain or legitimize the administrator's status in the school district organization. It is certain, however, that the exclusion of administrators from the powerful new teacher bargaining groups tended to alienate them from the professional team philosophy common in the 1940s and 1950s and evident in the membership appeal of the National Education Association.

Kaufman (1970) suggests that the principal task of educators and administrators is no longer to provide instruction, facilities, equipment, or learning resources but is, rather, to provide learning management—that is, planning, organization, designing, implementation, revision, and evaluation of learning opportunities. James agrees that the role of educational administrators is changing. "The new emphasis on efficiency is challenging our historic preoccupation with minimum standards . . . and the pursuit of excellence" (1969, p. 19). There exist "pervasive demands for improving our system of decision-making in education" (James 1969, p. 62).

Further acknowledgment of the changing nature of school administration has come from Conner, former executive secretary of the American Association of School Administrators. He noted that educational administrators are by necessity becoming more quantitatively oriented.

> As responsibilities increase and become more complex, school administrators will have to intensify the search for technology that will help in the resolution of issues. The intellectual technology based on systems and the machine technology based on the computer will necessitate new ways of thinking. In addition, the modern educational decision-maker will have to comprehend the special language and techniques of cost-effectiveness analysis, systems planning, operations research simulation, and computer-based information systems to reduce uncertainties and ensure a higher probability of effectiveness. (Conner 1969, p. 8)

Additional documentation of the trend toward the application of quantitative analysis (or what is called "new management techniques") in school administration is offered by the staff of UCEA:

> During recent years concepts associated with systems analysis, systems planning and systems design have begun to be diffused into education.

> Personnel in educational organizations have become more interested in new management techniques. In addition, computers and management information systems are beginning to be developed to support the application of the new management techniques. Both business and government have played and are continuing to play an important role in encouraging greater use of special technologies in education. (Culbertson and others 1969, p. 6)

Brown (1972) noted a similar trend toward quantitative analysis in the educational literature. He reviewed two journals—*Educational Administration Quarterly* and *Administrator's Notebook*—to determine the kinds of research articles they contain. He described two general modes of knowledge base generation—the humanistic, involving learning theory and soft data, and the scientific, involving formalized theory and hard data. He found a heavy imbalance favoring the humanistic mode but a growing trend toward the scientific. Thus, in print as well as in practice, there is a growing trend toward quantitative analysis in educational decision-making.

Simon (1966) defines the decision-maker as a man at the moment of choice in an environment that permits freedom to make a selection and provides a set of alternatives from which to choose. He explored the differences between traditional and modern decision-making techniques and developed the taxonomy in table 2.

TABLE 2

Types of Decisions	*Traditional*	*Modern*
Programmed	1. Habit	Operations research
Routine, repetitive decisions	2. Clerical routine	Mathematical analysis
Organization develops specific processes for handling them	Standard operating procedures	Computer simulation
	3. Organization, structure, common expectation of subgoals, well-defined information channels	Educational data processing
Nonprogrammed		
One-shot, ill-structured, novel policy decisions	1. Judgment, intuition Rules of thumb Selection and training	Heuristic problem-solving

The most important difference between the two approaches is the increasing emphasis accorded analysis, especially quantitative analysis, in modern decision-making.

This discussion of the changing role of school administrators has revealed several trends that relate to quantitative methods. First, administrators are developing the values and skills of a managerial class. Second, this change from a humanistic team leader to a managerial decision-maker is requiring administrators to develop and refine their skills in analysis, especially quantitative analysis. Third, the quantitative skills most appropriate for a manager are now manifesting themselves in the management technologies and in decision-related analysis. Fourth, most educational research and practice is becoming more quantitative and decision-oriented.

It can be concluded from these trends that school administrators need background in and exposure to the techniques of quantitative analysis in addition to traditional statistical methodologies. This background and exposure is needed if administrators are to keep up with the literature, to perform adequately in their planning and decision-making tasks, and to evaluate and assess the utility of these techniques in specific planning situations. Educators "who continue to pay little attention to redirecting their purposes and planning will simply be eliminated from consequential decisions if present trends toward . . . purposive redirection of educational institutions continue" (James 1969, p. 63).

A special commission created by AASA has supported the view that educational administrators must be trained in quantitative analysis. The Commission on Administrative Technology concluded that

> New skills, concepts, and understandings must be developed. It is essential that considerations of the potentialities and realities of administrative technology [quantitative analysis] be included in preparation programs for school administrators and in in-service programs. (Knezevich 1969b, pp. 158-159)

Quantitative analysis can play an important role as an aid to the school administrator attempting to come to terms with his new role as managerial decision-maker. The utility of quantitative analysis is of course evident on a practical level. But its value is also evident in its tendency to lead the administrator to adopt a stronger administrative stance.

The pragmatic force of quantitative analysis has been highlighted by the AASA Commission on Administrative Technology. The commission noted two means by which quantitative analysis can aid educational administrators. First, its tools and techniques can provide administrators with more available working time by freeing them from "the drudgery of time-consuming routine tasks." Second, quantitative analysis "will enable the administrator to generate meaningful long-range plans, try out or simulate proposed courses of action, and develop more meaningful evaluation and control procedures" (Knezevich 1969b, pp 101-102).

In addition, the very processes of quantitative analysis can enhance administrative decisions. Since quantitative analysis involves systematic examination of the structures, functions, and objectives of services, the exercise of this process can bring more thorough understanding on the part of administrators. This understanding in turn can increase their effectiveness in decision-making (James 1969, p. 63).

As quoted by Farmer, Hayes has focused on the power of the *process* of quantitative analysis:

> I believe that the greatest impact of the quantitative approach will *not* be in the area of problem *solving*, although it will have growing usefulness there. Its greatest impact will be on problem formulation: the way managers *think about their problems*—how they size them up, bring new insights to bear on them, relate them to other problems, communicate with other people about them, and gather information for analyzing them. In this sense, the results that "quantitative people" have produced are beginning to contribute in a really significant way to the *art* of management. (Farmer 1970, p. 21)

THE PROMISE OF THE QUANTITATIVE ANALYST

We have seen that quantitative analysis can serve as an aid to educational administrators. The specialist in educational quantitative analysis is best prepared to utilize these tools and techniques to their fullest advantage. AASA defines the educational quantitative analyst as "a person who has acquired highly developed skills in the use of sophisticated quantitative analysis techniques but at the same time possesses a very sophisticated understanding of the missions of educational institutions" (Knezevich 1969b, p. 115).* Further, AASA believes that a quantitative analyst is "an important new member of every administrative team" (p. 114).

*AASA terms these specialists educational systems analysts.

However, Sisson noted that as recently as 1967 such specialists were hardly ever available (1970, p. 679). Moreover, it is unlikely that the present widespread practice of line promotion on a seniority basis will provide the necessary specialists (James 1969, pp. 56-57). New types of personnel are needed (Knezevich 1969b, p. 103).

One might question the value to a school district of a specialist in quantitative analysis. His work is subject to two major limitations. First, available models cannot reliably relate input variables in education (such as students, subject matter, teaching methods, and teachers) to immediate outputs (such as learning of facts, skills, and attitudes), because the "physics" of learning is not clearly understood. Second, the strong influence of political forces such as school boards, PTAs, community advisory councils, teacher unions, taxpayer groups, and minority group coalitions greatly determine planning decisions in some, mostly urban, districts.

However, even in large urban districts there is a host of problems subject to little political influence and amenable to quantitative analysis. These problems include repair-replace decision-making, school bus routing, and student scheduling. The additional cost to a district for a specialist in quantitative analysis might be justified solely on the basis of the need for solutions to such tactical problems. In solving such problems the quantitative analyst's role would be very similar to that of his counterpart in the private and military sectors.

In addition to solving a school district's routine operations research problems, the quantitative analyst can be a resource to the administrative staff. He can establish a spirit of inquiry, assist school decision-makers in the analysis of policy questions, and lead school officials to ask the right questions concerning benefits, cost-effectiveness, and similar quantifiable problems.

A quantitative analyst can make important contributions even in areas subject to political influence. The analyst can articulate to the community, the school board, and political action groups the results and policy implications (both long- and short-range) of his research. Because education must rely on local financial support, the quantitative analyst, working in close cooperation with school officials, may also be called on to articulate the future plans and policies of the school district to an increasingly hostile electorate. In fact, explaining school district plans during campaigns for bond

issues and tax levies might be one of the analyst's most important responsibilities and might more than compensate for his salary.

The training of a school district analyst should thus prepare him for three essential or principal functions:

1. Studying the numerous school planning problems that are tactical in nature and amenable to straightforward, operations research type of quantitative analysis. Only in this capacity is the role of the educational analyst similar to his counterpart in business and industry.
2. Establishing a spirit of inquiry in the district, and leading school officials to ask the relevant questions concerning costs and benefits when evaluating and planning various school district programs.
3. Articulating school district plans to community and political action groups in the district, and attempting to use quantitative analysis to resolve conflict.

The Dallas, Texas, Unified School District recently sought an "education systems analyst" to assist the district in its planning efforts. Table 3 describes the characteristics of the individual they were seeking.

Because the Dallas job description emphasizes quantitative analysis, methodological competence is stressed. As the field expands and the function of the educational systems analyst develops, the problems addressed will probably include more general or "effectiveness"-oriented school issues. In this broader role the educational systems analyst will need a more diverse educational background. A curriculum to prepare an analyst to solve these problems must provide training in human relations, behavioral science, and communciations, as well as in the tools and techniques of quantitative analysis and related mathematical skills.

It is imperative that strong communication channels be developed between the analyst and the decision-maker. It has been noted that a decision-maker can effectively utilize the recommendations of an analyst only if he believes in the analyst and understands the techniques he uses (Sisson 1970). Thus, for quantitative analysis to reach its full potential in education, it is imperative that all educational administrators develop an understanding of, and appreciation for, its tools and techniques. Schools of education can foster the application of quantitative methods in education by

TABLE 3

DESIRED CHARACTERISTICS FOR THE POSITION OF EDUCATIONAL SYSTEMS ANALYST

(Dallas Unified School District)

Experience
Program budgeting—design and implementation
Descriptive simulation
Management information systems—design and implementation
Data retrieval systems
Computer programming—at least some "hands-on" experience and an appreciation of the problems and limitations involved.
Organizational planning, plan-making, strategic planning—whatever name you like, for responsibility for planning/implementing the goals, strategies, organizational structure and functions, for some significant piece of an organization.
Experience in a bureaucratic environment at the federal, state, county, or local level—LEA or TEA-type experience preferred.
Numerical analysis/methods experience or least education—e.g., diophantine programming; integer, dynamic, linear/non-linear programming; direct search techniques, etc.
Evidence of ability to synthesize and design
Education
Mathematics through vector spaces, non-linear optimization theory, probability theory.
Educational/industrial administration; management courses (a great deal). In general I would prefer education in the esoteric and experience in the mundane. Esoteric would be mathematics and optimization theory, the mundane would be accounting, organizational theory, and this sort of thing.
Computer science—a minor amount, especially, though, information retrieval systems.
Organizational theory, heavy exposure preferred.
Systems analysis techniques—not the introduction or overall exposure approach, but tough do-it-type courses, the ones with long case studies of one or two semesters' length. In other words, design problems that have to be solved that are significant.
Planmaking or planning—especially in educational planning.
A few courses in accounting, especially revenue and cost accounting. A good cost accounting course, a really good one could be invaluable. In governmental accounting, revenue expenditure courses would be valuable, too.
Four or five courses in statistics, the more the better. Certainly it should include regression analysis, analysis of variance and sampling theory.

including an introduction to these tools and techniques in the curriculum of all educational administrators.

Furthermore, certain departments of educational administration might choose to offer specialization in quantitative analysis. Researchers and practitioners graduating from such a program should be prepared to increase dramatically the scope and effectiveness of these methods. In the past, a primary limitation of quantitative analyses in education has been that the studies were conducted either by analysts who were not sufficiently acquainted with problems and limitations inherent in education or by educators who were not sufficiently acquainted with quantitative methods. The research or practicing specialist in educational quantitative analysis could strengthen the bridge between quantitative analysis and educational problems. Such closeness between these two areas should result in analyses of higher quality, which, in turn, should generate increased confidence in the applicability of these tools and techniques.

Problems and Issues

Application of quantitative analysis to educational administration is by no means simple and straightforward. Both practical and theoretical problems must be faced. The practical problems center around three issues: the nature of quantitative analysis, the role of the quantitative analyst, and the organizational effect of the application of quantitative analysis. The theoretical problems center around the question, "Can the schools be viewed as factories?"

Practical Problems

The nature of quantitative analysis. Several problems arise from the nature of quantitative analysis. First, its complexity leads to confusion. Second, its often overstated promise of problem-solving leads to disappointment. Third, its quantitative nature often leads to biased analyses. And finally, its expense leads to unequal availability.

Knezevich (1969a) has noted that school administrators are confused about the nature of quantitative analysis (specifically the systems approach). He cites several contributing factors.

> Confusion among administrators as to the meaning and potential of the systems approach can be partially attributed to its over zealous

> adherents, semantic difficulties among experts, and its application to minor pedestrian problems. (p. 129)

Perhaps this confusion explains why a recent survey of school superintendents indicated that only 19 percent considered skills in quantitative analysis to be essential to maintaining effectiveness as administrators (Knezevich 1972).

The excessive zeal of quantitative analysis proponents often results in analyses that are prepared with an enthusiasm unmatched by capabilities (James 1969 and Durstine 1970). This practice, in turn, "may generate negative reactions because of an inability to deliver on inflated promises" (Knezevich 1969b, p. 158).

Even under the best circumstances, quantitative analysis by its very nature emphasizes quantitative data. This may result in analyses that unjustifiably favor quantitative data over qualitative information (Culbertson and others 1969).

In any case, the application of quantitative analysis can involve a large expense (Durstine 1970), even though the expenditure should be justified in the long run (James 1969). The expense of quantitative analysis makes it more readily available to wealthy school districts than to poor ones. As Durstine has noted, "It seems to be a perverse law of nature that efficiency of operation is a luxury more available to those who have, than to those who have not" (1970, p. 329).

The role of the quantitative analyst. It is important to note that the quantitative analyst is seldom the decision-maker himself. However, the complex nature of quantitative analysis often leads the analyst to play a more important role in decision-making than he should.

> Because the tools of modern technology are relatively more complex than those which are presently commonly utilized in education, and because specialized personnel are required in the development and implementation of many approaches, there is a danger that basic administrative decision-making will be unknowingly delegated to the technologists who are employed because of their specialized competence. (Knezevich 1969b, pp. 157-158)

It is imperative that the role of the analyst be kept within bounds.

> Essentially he provides *information* for decision-making. He is rarely the decision-maker himself. And information, per se, does not make decisions. People do. His job is to put knowledge at the disposal of power—no more and nothing less. (Keppel 1969, p. 123)

Organizational effect. A final set of practical problems relates to the effect of the application of quantitative analysis upon the organization. Farmer (1970) has noted that "no organization can be comfortable when there is a reexamination of basic objectives and an evaluation of institutional performance" (p. 37). Often such reexamination is the explicit intent of quantitative analysis. Furthermore, its tools and techniques require "a sometimes frightening future orientation, where objectives may change markedly, technology may be substituted for human effort, and existing arrangements are almost certain to become irrelevant" (James 1969, p. 37). This prospect in turn may upset those school officials who perceive the school as a "stable, static organization with its solid objectives rooted in its history of past performance" (James 1969, p. 37). In brief, the application of quantitative analysis in a school system may generate a temporary lowering of morale because it disrupts standard operating procedures (Knezevich 1969b).

THEORETICAL PROBLEMS

Several theoretical problems revolve around the question, "Can schools be viewed as factories?" An affirmative answer to this question was advanced as early as 1916 in Cubberley's textbook, *Public School Administration:**

> Our schools are, in a sense, factories in which the raw products (children) are to be shaped and fashioned into products to meet the various demands of life. (Cubberley 1916, p. 338)

As recently as 1967 both the assistant commissioner for educational statistics and the director of the Division of Operations Analysis of the United States Office of Education held an identical view:

> Educational processes are analogous to other production processes; they transform input material (partially educated individuals) into output products (better educated individuals). (Mood and Stoller 1967, p. 74)

Other writers have been apprehensive about using this analogy. Pfeiffer believes that viewing schools as factories is as incongruous as viewing Proctor and Gamble as a "detergent university" (1968, p. 13). Durstine considers the factory analogy useful "as long as

*This text was described in 1927 as "the most widely read and influential book on school administration of our generation" (Counts 1927, p. 84, cited in Callahan 1962, p. 96).

we don't get carried away by that model" (1970, p. 33). He believes one advantage of the model is forcing recognition of the differences between educating and manufacturing. Two important differences he notes are the concern with rejects from the educational system, and, in education, the active role "inputs" play in their own transformation.

Another important difference is that production theory is well established, whereas several authors have pointed up the *lack* of educational theory (Dror 1969, Sisson 1969, Froomkin 1969, and Boulay 1969). More specifically, it is difficult to identify and quantify the inputs and outputs of the educational process.

Inputs. After a thorough review of the literature on educational production functions, Kiesling concluded that we do not know "the proper dimensions of the vector of educational inputs. Is a master's degree in education a relevant teacher input? A year of experience? A sense of humor?" (1971, p. 3). Froomkin concurs:

> Past studies have indicated that number of years in preparation, years of experience, or measurable interest in the discipline being taught . . . do not predict very well, if at all, the ability of a teacher to teach. Hence, one of the most important inputs in the educational process, the teacher, cannot be evaluated until measures of effectiveness are found. (1969, p. 382)

Furthermore, the teacher is by no means the only input into the learning process. The process can be viewed as a complex interaction of many student-related variables: family socioeconomic status, home educational environment, peer influence, learning motivation, native ability, and school quality (Coleman 1966 and Kiesling 1971).

Outputs. Numerous researchers have noted the complex multidimensional nature of educational output (Weisbrod 1964, Thomas 1967, Hartley 1968, Hirsch 1968, Durstine 1970, Kiesling 1971, and Boulding 1972). Durstine observes that the ends of the educational process are "highly variable among individuals, places, and times, and customarily not very precisely defined" (p. 330). A taxonomy of educational outputs offered by Boulding (1972) views educational institutions as providers of knowledge, skills, custodial services, certification, and community activities.

Weisbrod (1964) provides a more detailed delineation of educational benefits. He notes that the benefits of education accrue to students in several forms as well as to individuals other than stu-

dents. The benefits accruing to students include increased earnings, the opportunity to obtain further education, broadened individual employment choices, the opportunity to protect themselves against technological change, and nonmarket returns such as enhanced enjoyment of life both in the present and in the future. Nonstudents who receive benefits from the educational process include the student's current family who receives child care service, the student's future family who receives a better home educational environment, neighbors, taxpayers, and future employers.

Blaug has noted that

> the failure to quantify the consumption value, the external effects, and all other social and cultural contributions of education are characteristic of all current economic approaches to educational planning. . . . We simply do not know at present how to accurately measure benefits of education that are not directly reflected in the enhanced lifetime earnings of educated people. (1968, p. 181)

Criteria. Harmes notes another theoretical problem—the typical reliance on only one criterion of educational effectiveness, that is, "how many of the learners attained the objectives intended as outcomes of the learning process" (1970, p. 46). He concedes that this is one potential criterion, but notes that there are others worthy of examination, including: "(1) objectives more aligned with goals, (2) increased efficiency, (3) reduced undesirable side-effects, (4) increased reliability, and (5) more objectives accomplished" (p. 46).

3

Potential of Preparation Programs

This chapter discusses the ideal content of hypothetical preparation programs in educational quantitative analysis. Such programs should be designed to serve three distinct groups: general administrators, practicing specialists in educational quantitative analysis, and researchers in this field. Each group plays a different role; thus, each should undergo different training.

THE GENERAL SCHOOL ADMINISTRATOR

The practicing administrator is on the firing line as a decision-maker. By necessity, he must be a generalist and above all must possess insight and an analytical orientation in order to evaluate new proposals and make decisions. The general administrator should be trained to develop quantitative reasoning and analytical capabilities as well as an appreciation of the more technical aspects of quantitative analysis. He should be trained to more clearly define educational objectives and should be taught to emphasize the generation and evaluation of alternative routes

toward these objectives. He should not be trained as an artisan, but he must be trained to appreciate and utilize the art of quantitative analysis.

It is important to emphasize that programs constructed for the practicing decision-maker should *not* be designed to make him an expert in the use of the various technical tools and concepts that are involved. Rather, these programs should be designed to acquaint him with what tools and concepts are available, under what situations they can be used, and, most importantly, what their limitations are. It is possible that most program analyses will be performed by central office staff or outside consultants. Other district personnel should know what this group can do and be able to interpret and apply the results of such analyses. Moreover, all decision-makers should be able to apply analytical thinking to the decisions they must make daily. In brief, general administrators should be trained to criticize and utilize analyses, rather than formulate them themselves.

The Practicing Specialist

The true artisan in the field is the specialist in educational quantitative analysis. The job market for educational quantitative analysts will probably grow during the next decade. To retain their influence and leadership in education, schools of education will have to provide personnel to fill this increasing demand.

Two important questions must be resolved, however, before developing courses and curricula for training specialists in quantitative analysis. First, should a graduate school of education develop its own courses in quantitative analysis instead of directing its students to the courses already available in graduate schools of business administration, economics, or engineering? Second, if schools of education choose to develop courses in systems analysis-operations research, should the course content be job or knowledge oriented?

It is relatively easy for an education department in a large university to justify developing its own courses in quantitative analysis. First, the inflexibility of the narrow, specialized instruction in other departments has typically been rejected by graduate students in education. Thus, just as statistics, historically centered in the math department, is presently being taught (especially in

large universities) in departments such as public health, education, engineering, business administration, sociology, and anthropology, so will quantitative analysis tend to be taught in numerous departments.

Second, a large graduate department of education can usually generate sufficient enrollment from the various areas of education—curriculum, comparative education, higher education, evaluation, adult education, instructional technology, and so forth—to make these courses economically viable. In addition, because systems analysis and associated methodologies are applicable to other areas in education, courses in quantitative analysis would tend to upgrade training throughout the graduate program. Therefore, for most large graduate schools of education, an intradepartmental approach to these techniques is appropriate, with *narrow and specialized training* to be handled by other departments.

The overall instructional goal of the inclusion of these courses in a school of education is the development of a curriculum that

1. will present the maximum amount of relevant content in a given amount of time, and
2. will allow for two levels of course work—one for students desiring a simple introduction to quantitative analytic procedures, and one for those desiring a more thorough treatment of these procedures

Even after it is established that courses in educational quantitative analysis should be taught in education departments, the difficult question of the content and intensity of the course of study remains.

The curriculum in this specialty must encompass the skills (such as management science technologies, operations research techniques, computer technologies, communications, and behavioral science methods), attitudes (such as systems analysis and PPBS), and knowledge (such as the political, social, legal, and economic foundations of education) required of a quantitative specialist both in a school district and in a research or private corporation engaged in educational quantitative analysis.

The methodological components of an educational quantitative analysis curriculum must follow the guidelines specified by descriptive and normative analysis, with slightly more emphasis on the latter. Table 4 summarizes the relationship between some of

the tools and techniques of quantitative analysis and the types of analysis to be performed.

The reader should be aware, of course, that it is impossible to construct a table in which each technique is assigned exclusively to one analytical category. Obviously, systems analysis and PPBS might require the use of any of the analytical techniques. The main object of table 4 is to distinguish between the analytical tools used in descriptive and normative analysis. Descriptive analysis specifies only system interaction of the model, whereas normative analysis specifies constraints and an objective evaluative performance measure. Thus, normative analysis requires an optimization model, whereas multivariate statistical procedures are usually sufficient for descriptive analysis.

The mathematical portion of a quantitative analysis curriculum must emphasize those tools and techniques that an analyst uses most frequently. Based on a survey of the literature, table 5 records the frequency with which various operations research techniques are used and the types of educational planning problems to which they are applied. The widespread application of mathematical programming might be partly due to two factors. First, computer software is available for solving large-scale linear programming problems. Second, systems operating under constraints and specifying a criterion measure of effectiveness and interrelatedness are suitable for application to typical school administration problems. For these reasons, the mathematical programming model is one of the more important subjects for an educational operations research course. Computer simulation (hence, computer programming skills) should also be stressed as important deterministic models in educational planning. Models, such as Markov chain analysis and Monte Carlo techniques, are some of the more important *stochastic* models that should be taught in graduate programs. Dynamic programming should probably be emphasized because of its great versatility. Unfortunately, each dynamic programming problem is unique, and the formulation and solution of such problems require both sophisticated computer programming skills and mathematical ingenuity.

The curriculum for candidates preparing for careers as quantitative analysts in school districts would include courses in communications, educational administration, and the behavioral sciences. Candidates preparing for research or college teaching

TABLE 4

TECHNIQUES OF EDUCATIONAL QUANTITATIVE ANALYSIS

Type of Analysis	*Technique*	
	Present Time Period	*Extended Time*
Descriptive Analysis		
(system interaction defined between variables)		
(Examines questions related to measurement of change or description of the system)	–Computer Simulation	Markov Chain Analysis
	–Traditional Statistical Analysis	Bayesian Techniques
	–Statistical Inference	
	–Psychometric Research Measurements	
	–Multivariate Statistical Analysis	
Normative Analysis		
(an objective or criterion measure is specified and constraints recognized as well as system interaction between variables)	–Production Theory	
	–Leontief I-O	–Dynamic Programming
Input Trade-off Analysis (Examines questions related to system efficiency, that is, *tactical* questions)	–Linear, Integer, and Nonlinear Programming	
	–Econometrics	
	–Game Theory	
	–Queuing Theory	
	–Inventory Theory	
Output Trade-off Analysis (Examines questions related to system effectiveness, that is, *policy* questions)	(SYSTEMS ANALYSIS–PPBS)	
	–Utility Theory	

TABLE 5

TYPES OF EDUCATIONAL PLANNING MODELS WITH ASSOCIATED MATHEMATICAL TECHNIQUES

Enrollment Projections	*Resource Allocation*	*Scheduling*	*Manpower Planning*	*Evaluation*	
X			X	X	Regression (production function studies)
X	X	X	X	X	Computer Simulation
	X	X	X	X	Mathematical Programming
X		X	X		Simulation Monte Carlo
X			X		Leontief I-O
				X	Game Theory
		X			PERT
		X		X	Queuing Theory
	X		X		Dynamic Programming
X		X	X		Markov Chain Analysis
X	X	X	X	X	Heuristic Models

would take more methodology-oriented courses, such as instructional evaluation, tests and measurements, and survey research methods.

Educational quantitative analysts also need the basic skills and techniques of statistical analysis, such as regression analysis, factor analysis, canonical correlation, and discriminant analysis, if they are to perform descriptive analysis in educational settings. Miscellaneous techniques, such as Bayesian analysis, PERT, Delphi, and game theory should be taught if time is available. Most students, however, can acquire the major concepts of these techniques on their own.

Because quantitative methodologies are relatively new to education, a large initial investment in instructor time will be required to prepare course sequences. Compiling film teaching materials, computer programs, and reading lists, developing liaisons with school districts, preparing course syllabi, evaluating student

problem sets, and constantly evaluating and modifying the curriculum will consume hundreds of man-hours.

The investment in time, however, should pay great dividends when the students from these programs are ready to do their own research and to enter school organizations as highly skilled personnel. Because they will have a thorough appreciation of the limitations and advantages of quantitative analysis as well as an understanding of the political, legal, and social forces operating in a school district, these specialists will, it is hoped, become effective agents of change in education.

The Research Specialist

The researcher in educational quantitative analysis plays an important role in bridging the gap between theory and practice. Past applications of quantitative analysis have often been limited by the insufficient training of the analysts. These studies have often been conducted either by individuals who were well trained in techniques but were not sufficiently acquainted with the specifics of the problem, or by individuals who had a firm grasp of the substantive issues but who lacked competence in quantitative methods. The research specialist should be trained to combine tools with substantive issues. He should then be prepared to generate studies of high quality, thus increasing the acceptance of quantitative analysis in the education field.

Through experimentation, the researcher attempts to generate educational alternatives, applies specific methodologies to a wide class of policy- or decision-related school district problems, and attempts to extend knowledge of the educational decision-making process. Since he must view education as a total system, his training cannot focus around one clearly defined area of inquiry, such as educational psychology or curriculum, or around a single class of decision-related problems. Instead, his field and the field of school administration in general should be quite interdisciplinary, drawing heavily on economics, political science, sociology, law, anthropology, and so forth. However, one of the purposes of the research specialist is to assist the practitioner by providing policy- or decision-related insights that could improve educational practice. To achieve this goal, the researcher may specialize in one or more of the following research approaches to education phenomena.

1. *The input-output approach* attempts to explain how educational outcomes are determined by the quantity and quality of educational resources received.
2. *The organization theory approach* views the impact of historical, social, legal, and political factors upon the school as an organization.
3. *Evaluation* attempts to ascertain if a large-scale intervention, such as a compensatory education program, will affect student outcomes.
4. *The experimental approach* surveys and attempts to evaluate alternatives to the present schools and, in general, attempts to reform the whole of education by examining the effects of the present system on students, teachers, and administrators.
5. *Efficiency-benefit-cost studies* look at means of improving educational practice by using defined goals and trying mixed inputs in order to maximize outputs.

For educational research to have an impact on educational practice, the research methodologies must be sound and, in some areas such as benefit-cost and input-output studies, strongly analytical and quantitative. Traditional statistical types of analysis are useful for most of the research areas defined above but do not compose the entire repertoire of analytical methodologies that the researcher should possess—especially for benefit-cost studies. These new supplementary skills discussed in this monograph are classified under the general heading of quantitative analysis. Typically, most graduate schools of education, if quantitatively oriented, have stressed the traditional forms of statistical analysis. As mentioned previously, it is only recently that the mathematical modeling techniques of operations research have begun to take their legitimate part in school administrator preparation.

4

Preparation Programs in Practice

The first portion of this monograph pointed out the need for administrators who are prepared in quantitative analysis methods. It established the need for *all* school administrators to develop an appreciation for, and understanding of, the tools and techniques of quantitative analysis. It also stated the need to train specialists in educational quantitative analysis and outlined the ideal content of preparation programs.

This chapter discusses programs already in practice for the preparation of educational administrators in quantitative analysis. The chapter describes several representative programs that illustrate how educational administrators are being prepared to utilize the tools and techniques of quantitative analysis.

These programs originate from two major sources: (1) colleges and universities; and (2) seminars, institutes, and workshops developed by educational administrators, consultants, research and development centers, and professional organizations. The formal college and university courses are typically directed toward

preservice personnel; the seminars, institutes, and workshops are usually directed toward inservice personnel.

The information in this chapter comes primarily from a special 1971 UCEA survey. Only some highlights of the more extensive programs in quantitative analysis are reported here. Because the programs are not described in great detail, the staff members in charge are named so those readers desiring more information can write to them directly. The programs described in this chapter seem to represent a fair cross-section of those available for training school administrators in quantitative analysis.

College and University Programs

Formal programs in quantitative analysis are relatively new. How new was made clear by the UCEA questionnaire, which revealed that most programs have been in existence for only two or three years. Many more schools are only now beginning to develop programs. Table 6 lists some operating and developing programs of schools that responded to the questionnaire. For each program, the table lists the number of courses available in quantitative analysis, the average number of students in the classes, the director of the program, and how long the program has been in operation. The table also indicates if a quantitative analysis specialist is available, if the courses are in the education department, and if an interdepartmental program is available.

A more extensive outline of the quantitative analysis courses available in all the programs surveyed by UCEA is available in the Appendix.

Most schools responding to the survey indicated that their students are being prepared for positions as school district analysts and college teachers. Some colleges, however, indicated an orientation more amenable to placing graduates in regional laboratories, research institutions, and management consulting firms. A significant number of colleges do not want to prepare specialists but prefer to produce school administrators who are familiar with the tools and techniques of quantitative analysis.

To suggest the diversity of programs for preparing school administrators in quantitative analysis, four are presented here in some detail. The Iowa-PAERIS program (the oldest) and the University of California at Santa Barbara educational executive

TABLE 6

FORMAL EDUCATIONAL QUANTITATIVE ANALYSIS PROGRAMS

University or College	*Are QA Courses Taught in Ed. Dept.*	*Is There a QA Specialist*	*No. of Courses Taught in QA*	*Average No. of Students in Courses*	*Joint Programs w/ Other Depts.*	*Present Director of Program*	*No. of Years Program in Operation*
Florida State University	Yes	Yes	2-6	12	Yes	Frank Banghart	5
Iowa	Yes	Yes	2	12-20	No	Ralph Van Dusseldorp	4
New York University	Yes	No	1	20	No	Harry Hartley	2
Ontario Institute for Studies in Education	Yes	Yes	13	10-15	No	Donald Levine George Tracz	3
Stanford University	Yes	Yes	—	20	Yes	Henry Levin	4
University of California Berkeley	Yes	No	5	6-10	No	George Kleindorfer	4
University of California Los Angeles	Yes	Yes	4	10-15	No	James E. Bruno	3
University of California Santa Barbara	Developing					Norman Boyan	
University of Florida	Yes	No	2	—	No	G. R. Boardman	2
University of Georgia	Yes	No	2	7-10	No	None yet	3
University of Illinois	Yes	No	1	20	No	Robert Burnham	1
University of Missouri	Yes	No	—	7-15	No	Howard Heding	5
University of Oregon	Developing					J. F. McNamara	
University of Tennessee	Yes	Yes	1	15-20	Yes	Kenneth Tanner	1
University of Utah	Yes	No	1	15-20	No	Edwin A. Read	3
University of Wisconsin	Yes	No	2	unknown	No	Dennis Spuck	2

Source: Special UCEA Survey, 1971. Supplemented by authors.

program (the newest) are presented to show how the direction of such programs has shifted in only a few years. The University of California at Los Angeles program in educational policy and planning is presented because the authors of this paper are associated with it and because it is representative of programs based entirely in large schools of education. Finally, the Ontario Institute for Studies in Education's program in educational planning is presented because of its comprehensiveness.

The reader should in no way construe the selection of these programs as a judgment of their merit or distinction; they were chosen only because they present a representative cross-section of programs used to prepare school administrators in quantitative analysis.

IOWA-PAERIS PROGRAM

The University of Iowa Program for Administration for Educational Research and Information Systems (PAERIS) was perhaps the first federally funded program specifically intended to train practicing specialists in educational quantitative analysis.

The course work requirements of the program are designed to provide students with background in each of three areas:

1. educational administration
2. research and statistics
3. data processing and computer science

The suggested courses in educational administration cover the foundations and philosophies of educational administration, finance, curriculum, law, and personnel management. These courses can be taken with emphasis on elementary, secondary, or higher education levels. Students fulfill the research and statistics requirement by taking at least five courses in these areas. The minimum requirements for data processing and computer science are fulfilled by three courses in the management of educational information. Emphasis is on the use of the computer as a tool in the processing of information.

A number of PAERIS program courses are often taken outside the school of education. Computer science and theory of statistics can, for example, be taken in the mathematics department;

systems analysis, operations research, and decision theory in the business college; communication theory in the journalism department; and operations research and systems design in the department of industrial management engineering.

In addition to the regular course work, each student is required to participate in a variety of experiences that fall under the general title of PAERIS Practicum. The practicum serves two primary purposes. In it students should gain appropriate knowledge and skill not included in the regular courses and seminars, and experience in applying knowledge and skill to "real world" situations and problems.

The knowledge component of the practicum involves studying topics not covered in classes, listening to and conversing with guest speakers from inside and outside the university, and visiting various educational agencies, conferences, and conventions.

Of all the courses in the Iowa program, only two are devoted to educational quantitative analysis. One, Educational Systems Analysis and Operations Research, focuses almost entirely on the application of operations research to education. The class emphasizes the quantitative tools of network analysis (PERT), probability, decision tables, strategies, mathematical programming, queuing, simulation, and gaming. The other, a seminar in computer applications in education, varies in focus from year to year but is often devoted to operations research.

In summary, the PAERIS program is generally tailored to train practicing specialists in educational quantitative analysis. By exercising control over the quality of entering students (math majors with high GRE scores) and by making use of other departments in the university for specialized courses, the PAERIS program is conceptually very sound. Furthermore, those responsible for the program are to be commended for providing a research practicum and for making use, in general, of university resources in other departments.

However, one weakness of this program might be its apparent lack of integration with the social or behavioral sciences. Furthermore, the courses in the program seem to be oriented primarily to specific operations research techniques. This narrow focus yields specialists who are capable of handling tactical problems but who might be somewhat lacking in their contributions to the solution of policy and planning problems.

ONTARIO INSTITUTE FOR STUDIES IN EDUCATION (OISE)

The Ontario institute functions both as a graduate school of education for the University of Toronto and as a research and development center. The resources that equip the institute to fill these two roles also enable it to offer what is probably the greatest number of educational operations research courses available in any graduate program. The institute offers both the master of arts and doctor of philosophy degrees with specialization in educational planning.

A majority of the operations research courses are taught in the Department of Educational Planning by a small group of educational OR specialists. Students wanting to specialize in operations research are usually required to have a bachelor of science degree or equivalent training in mathematics.

The following courses are offered in the school of education.

1700X Theories of Micro-Educational Planning

A study of concepts of town planning, regional planning, and land use as applied to school planning; concepts of economic and social planning as applied to educational service, together with the range of work of planning offices; the relation of planning to administration, of planning decisions and political decisions, and of planning and educational research.

1703X Educational Planning: Economics of Human Resources

An analysis of the contribution of investment in human capital to economic growth, with special reference to problems of manpower and educational planning.

1704X Quantitative Methodologies of Educational Planning

The intensive study of a selection of techniques drawn from the mathematical and statistical sciences in order to assist the educational planner in developing a quantitative approach to planning problems, in evaluating contributions to the educational planning literature, and in bridging the communications gap between educational decision-makers and mathematically trained researchers.

1705X Population Studies

An introductory course dealing with the problems, techniques, and methodology of demography. Topics include population measurement and prediction; mortality, and expectation of life; measurement of fertility and its differentials; estimation of internal migration, and consideration of patterns of urbanization and location; determinants and consequences of international migration; the relation of population to resources; population policies; the composition of population; the relation of demographic factors to education.

1706X The Budgetary Process in Educational Planning

This course will concentrate on the links between planning and resource allocation in public education. Recent developments and new concepts in budgeting will be examined, with emphasis on their applicability to planning for expenditures on human resources in general, and on education in particular.

1707X Educational Systems Models

The main emphasis will be on the class of macro-models known as flow models, which will be studied intensively with respect to basic concepts, mathematical formulation, empirical estimation, and computational form. A model structure that uses Ontario data will be used by the students for the construction of example simulations. Other systems models used in educational planning, such as resource allocation models and institutional models, will also be discussed.

1708X Educational Planning for Social Development

This course focuses upon linkages between education and the social development of nations. Conceptions of social development will be examined and approaches to the measurement of dimensions of development relevant to these concepts will be evaluated. Evidence concerning the linkages between education and social development will be considered with a view to codification for the purpose of developing propositions useful to theory building.

1709X The Educational Planning Process in Developing Nations

This course will emphasize the pragmatic approach to educational planning in developing nations, in which the data customarily used may be incomplete or unavailable. The scope and range of the general planning process, and the process of educational planning, will be examined in the light of deficiencies in data and constraints of manpower, capital, and policy. The methodology for the conduct of planning in the more developed nations will be discussed in terms of its applicability to problems encountered in the less developed nations.

1710X Seminar: Controversial Educational Issues for Planners

An examination of divergent views on theoretical and practical issues and problems in education, which are relevant for educational planners, particularly those at the local level. Some issues to be examined: reorganization of the school year, community use of school facilities, individualized instruction, equality of educational opportunity, use of para-professionals in elementary and secondary schools, community involvement in the setting of school goals and programs, integration of exceptional children, and introduction of controversial programs.

1712X Manpower Planning and Manpower Utilization

An analysis of the theoretical foundations and empirical methodology of manpower planning. Topics include the concept of an occupation,

the relation between the level and structure of output and occupational distribution, alternative methods of forecasting skilled manpower needs, skill substitutability, the effect of technological change upon the demand for and utilization of skills, the flexibility of the educational system, and the exchangeability of different types of education and training.

3703X Workshop: Topics in Economics of Human Resources

This seminar is intended primarily for students in the second year of their program. Probable topics for student projects include macro-models of education, the production function, technological change, and manpower forecasting techniques.

3704X Seminar: Mathematical Models in Educational Planning

The purpose of this course is to examine and evaluate application of systems analysis, operational research, and related techniques to practical educational planning. Recent developments in comprehensive quantitative approaches to global educational planning problems will be examined, and their potential for improving the reliability of forecasts, and of the information base for planning, will be evaluated. Content of the course will be highly mathematical and advanced students will be encouraged to exploit course topics in thesis research.

3707X Seminar: Operations Research for Educational Systems

Topics will include: an introduction to stochastic processes, Markov processes, and elementary queuing theory; optimization subject to constraints by mathematical programming methods, with applications in educational systems; and introduction to the theory of games and statistical decisions, simulation and scheduling techniques.

It is readily apparent that OISE is distinguished for the extraordinary breadth and comprehensiveness of its program. The tactical orientation, as well as the emphasis on policy and planning, would serve other fields in a graduate school of education quite well. Furthermore, the institute's program is excellently integrated with the departments of economics, manpower planning, and other social sciences. It appears that this program would prepare students for a wide variety of educational positions.

Possibly one weakness of the program is its apparent lack of a research practicum for those students desiring real-world experience in educational quantitative analysis. Additionally, such a comprehensive course sequence would require a large staff and high enrollment within a school of education. Thus, the course offerings might be too extensive for most schools of education to staff effectively.

UNIVERSITY OF CALIFORNIA AT LOS ANGELES (UCLA)

UCLA has developed a sequence of five courses in educational quantitative analysis. The first two courses give a broad overview of microeconomic and macroeconomic planning. The other three courses provide more advanced work for quantitative specialists.

The first course, Information Systems and Educational Planning (242F), is a survey required of all students in the program. A background in elementary statistics is necessary. The survey contains an overview of systems-analytic techniques and an introduction to the quantitative skills prerequisite to subsequent courses. The systems-analytic techniques covered are management information system design (analysis of the Coleman Report) and the systems approach to educational planning (PPBS, OR, and systems analysis). The quantitative skills covered include computer programming (using the Scientific Subroutine Package), multivariate analysis (factor analysis, discriminant analysis, regression analysis, and canonical correlation), and linear programming and PERT.

Also, topics in the design of instructional systems (media mix, computer-assisted instruction, and cost-effectiveness analysis in instructional systems) and in educational planning in underdeveloped countries (earth satellites in instructional systems and investment in education) are presented. The purpose of these topics is to demonstrate the variety of educational planning problems amenable to quantitative analysis and to enhance the appeal of the course to other areas in the school of education.

The next course in the sequence, Strategic Planning in Education (246C), is a general introduction to the economics of education as well as to the macroeconomic view of planning in educational organizations. Here skills and knowledge presented in the first course are elaborated, placed in perspective, and their impact on policy formulation and planning extracted. New topics introduced in this class center around educational investment, educational production function, and so forth. The class also interprets the results of recent large-scale research studies and discusses the implications of the results.

The three remaining courses in the sequence are designed for students either desiring advanced work or majoring in educational quantitative analysis.

The first two weeks of Mathematical Modeling of Educational Problems and Processes (246A) focuses on advanced work with the Scientific Subroutine Package (random number generation, matrix inversion, and eigen-value/eigen-vector analysis) and on a general mathematics review (matrix algebra and differential calculus). The remainder of the class is devoted to the specific mathematical modeling techniques of operations research.

Emphasis is placed on deterministic modeling concepts such as linear programming, interpretation of post-optimal sensitivity analysis, Leontief input-output models, and two-stage least-squares models, along with stochastic modeling concepts such as Monte Carlo techniques, Markov chain analysis, dynamic programming in Markov chains, and queuing theory. The basic concepts and assumptions of each model are presented together with examples of their application to problems in educational planning and management.

The next course in the sequence is Advanced Topics in Educational Planning (246B). It provides an overview of Bayesian analysis, microeconomic theory, game theory, logit models, and differential equation models. Students divide their time between classwork and fieldwork in local school districts. For the most part, class time is spent studying research proposals and analyzing real-world problems amenable to quantitative analysis.

The final course is a practicum in Educational Planning (446A) devoted exclusively to dissertation proposal writing, short projects, and internships in local educational agencies.

The main topics covered in each of these courses are presented in table 7.

In summary, the UCLA program serves as a reasonable prototype for other graduate programs, but it suffers from a lack of formal integration with social and behavioral science departments in the university. While the principal topics in the field can be covered in these courses, the program is geared to the researcher in educational operations. However, with the set of four courses and the research practicum in educational policy, the program serves the needs of the practicing specialist in educational quantitative analysis as well as the needs of the general administrator.

UNIVERSITY OF CALIFORNIA AT SANTA BARBARA (UCSB)

The University of California at Santa Barbara's educational executive program will begin with the 1973-74 school year. The

TABLE 7

QUANTITATIVE METHODS ASPECT OF UCLA CURRICULUM IN EDUCATIONAL PLANNING

242F

Information Systems and Educational Planning
Systems Analysis
PERT and Linear Programming
Computer Programming
Multivariate Analysis
Management Information Systems Design

246C

Strategic Planning in Education
Macroeconomic Theory
Economics of Education
Policy Formulation
Production Functions

246B

Advanced Topics in Educational Planning
Benefit Cost Analysis
Advanced Topics in OR
Goal Programming
Bayesian Analysis
Two-stage Least-squares and Advanced Topics in Regression
Review of Microeconomic Theory
Differential Equation Models
Logit Models and Dynamic Programming in Markov Chains

246A

Mathematical Modeling of Educational Problems and Processes
Mathematics Review
Linear Programming with Cost Sensitivity Analysis
Leontief I-O
Markov Chain Analysis
Queuing Theory
Monte Carlo Techniques

446A

Practicum in Educational Planning
(dissertation research)
(internship)

program's goal is to prepare doctoral students as specialists capable of advising the chief executives of complex public and private educational organizations.

The UCSB educational executive program has developed performance criteria for each of three program objectives—purposing, planning, and evaluating. Table 8 lists these criteria.

The course sequence and the program objectives for each course are outlined in table 9.

TABLE 8

UCSB PERFORMANCE CRITERIA FOR THREE PROGRAM OBJECTIVES

1. *Purposing*	2. *Planning*	3. *Evaluating*
1.1 Identifying educational needs and demands	2.1 Projecting demands and needs	3.1 Determining and identifying the value dimensions of demands and needs
1.2 Setting educational goals and purposes	2.2 Converting statements of demands and needs into operational plans	3.2 Assessing alternative "presents"
1.3 Formulating and specifying educational objectives	2.3 Plotting alternative futures for education, especially in relation to alternative futures for society	3.3 Assessing simulated or projected futures
1.4 Selecting objectives of highest worth and pertinence	2.4 Allocating resources to optimize chances to realize plans	3.4 Auditing the implementation of programs and projects
1.5 Designing and/or interpreting value frameworks	2.5 Devising and managing pertinent information systems	3.5 Conducting surveys
1.6 Analyzing value content of decisions on goals and objectives	2.6 Identifying available and potentially available resources	3.6 Conducting experiments
1.7 Identifying social and political bases of values, choices of goals and objectives	2.7 Using pertinent planning tools (systems analysis, operations research, PPBS, PERT, CPM, etc.)	3.7 Using available, pertinent evaluation tools
1.8 Developing arguments to support investments in education	2.8 Determining prices and costs	3.8 Constructing and using appropriate evaluation tools, when necessary and/or pertinent
1.9 Developing arguments to support choices of specific goals and derivative objectives	2.9 Identifying inputs, throughputs, outputs	3.9 Drawing inferences from data provided by evaluation tools, other measures, and available data
	2.10 Identifying social and political costs of proposed programs	3.10 Determining benefits of programs and projects
		3.11 Assessing impact of social and political costs of programs/projects
		3.12 Assessing impact of social/political benefits and/or effects

TABLE 9

UCSB COURSE SEQUENCE AND OBJECTIVES

Course Sequence		*Objectives*				
		General	*Purposing*	*Planning*	*Evaluating*	*Leading*
Ed. 240a	The Administrator and Educational Purpose		x	x		
Ed. 240b	The Administrator and Educational Purpose		x	x		
Ed. 241a	Schools—Public Institutions		x	x		
Ed. 242	Schools—Complex Organizations					x
Ed. 244	Organizations and Interpersonal Relationships					x
Ed. 245a	School Finance			x	x	
Ed. 245b	Introduction to Economics of Education			x	x	
Ed. 245c	Resource Allocation in Education			x	x	
Ed. 246a	Evaluation of School Programs				x	
Ed. 246b	Evaluation of School Programs				x	
Ed. 247a	Seminar in Problems of Administration	x				x
Ed. 247b	Introduction to Educational Planning			x		
Ed. 247c	Advanced Educational Planning			x		
Ed. 114	Introductory Educational Statistics	x				
Ed. 214a	Advanced Educational Statistics	x				
Ed. 214b	Advanced Educational Statistics	x				
Ed. 219	The Evaluation of Student Learning I				x	
Ed. 220	Measurement and Evaluation				x	

The UCSB program, only now matriculating its first students, is one of the most thorough and well-planned of all the programs in educational quantitative analysis. Its creators have possibly learned from the mistakes of others.

As stated in the program description, it is directed primarily at the "educational executive." This program of courses (unlike the UCLA program) is geared specifically to the general administrator and the practicing specialist in educational quantitative analysis. Conceptually, the program integrates educational issues with research and management skills. The UCSB program could serve as an excellent model for small schools.

GENERAL RESULTS OF THE UCEA SURVEY

Although the descriptions of the various educational quantitative analysis programs currently developed or being developed are not detailed, the reader may extract the following conclusions from the brief descriptions presented in this chapter and in Appendix 1.

1. The majority of existing programs in educational quantitative analysis are only a few years old. The number of these programs has grown very rapidly in the past few years and most schools of education will probably institute such programs in the near future.
2. Because school districts are demanding specialists in educational quantitative analysis, the training of such specialists is rapidly becoming one of the principal tasks of educational administration departments. Education schools are beginning to emphasize the development of quantitative managerial skills, and at present there is a demand for professors possessing these skills.
3. The body of knowledge in educational quantitative analysis is now extensive enough for graduate programs to be developed.
4. The type of graduate program at a given institution seems closely related to the teaching personnel and funding sources. The goals and objectives—training researchers or school district personnel—seem to be determined by the individual institution.
5. The quantitative techniques emphasized in the operations research portion of quantitative analysis programs

are mathematical programming, PERT, and computer methods.

6. The large universities tend to develop programs for researchers, whereas the smaller schools place a greater emphasis on school district administrators.
7. The graduate programs have a sequence of two to five courses in quantitative analysis with only the more advanced courses involving a mathematics or statistics prerequisite.

Even though systems analysis stresses the interdisciplinary approach, most of the programs surveyed were methodologically oriented and disassociated both from other areas in the school of education and from other graduate departments that might offer curricular enrichment and insights into educational problems. A few programs, such as those at Stanford, U.C. Berkeley, and U.C. Santa Barbara, stress both the practitioner, or case study model, and the interdisciplinary approach. The survey results indicate the increasing emphasis on quantitative analysis in educational administrator preparation programs. At this time, however, course emphasis seems too methodological and not well integrated with the other disciplines in the school of education or in the university.

Most programs have prepared excellent reading lists. While it is difficult to ascertain the quality of what is taught, the scope seems adequate. Problem-oriented seminars using the systems approach might be further utilized. Attention in these courses should be given to clearer definitions of educational objectives, modeling of school operations, development of quantitative reasoning and analysis capabilities, generation of alternative solutions to problems, and communciation and articulation of results.

It is important to recognize that the purpose of these graduate programs should not be to make all students experts in the use of the various quantitative tools and concepts, but rather to introduce them to what methods and concepts are available, under what situations these can be used, and, most importantly, what their limitations are. If, for example, most program analysis is performed by a central group at the district level, the principal should know what analyses this group can perform for him and be able to interpret the results of such analyses. Moreover, he should be able to apply the analytical thinking emphasized in much of the training material to decisions he must make on a daily basis.

The UCEA survey indicates that only about one hundred doctoral students in educational systems analysis will be moving into research or staff positions with educational research organizations. Since new administrative positions in education are now constrained due to declining enrollments, declining support for education, and administrative appointment being based on minority membership, the potential impact of educational quantitative analysis on educational practice might not be realized.

What seems to be required is an emphasis on inservice or postdoctoral training in which school administrators in top administrative positions come back to the classroom to update their skills and to learn what has happened in other disciplines that might affect decision-making in their districts.

UCLA is now attempting to develop a consortium of school districts with a superintendent and two assistants from each district coming to school once a month. Two students from the graduate program will be placed on this team. The students will gain valuable internship training, while the school officials will learn the latest methodologies. The two assistants to the superintendent will be regularly enrolled doctoral students. They will meet for a full day once a week, while the superintendents will meet with the group only once a month in a workshop seminar with guest speakers. Problems common across districts will be identified, and by means of a team approach the problems will be analyzed.

Thus mixing inservice training with a preservice program might be extremely beneficial to all concerned. The superintendent could work on problems facing his district; the graduate students could benefit from internships; and the young assistants to the superintendent could develop the latest managerial skills and possibly earn a degree.

Several interesting inservice programs are oriented toward transmitting to school administrators the skills in, attitudes toward, and knowledge of quantitative analysis. These programs are discussed in the following section.

INSERVICE PROGRAMS

Inservice programs developed outside the formal university setting typically have been specifically designed to acquaint school personnel with the tools and techniques of quantitative analysis.

These programs have been sponsored by various sources including educational administrators, educational consultants, research and development centers, and scholarly organizations.

EDUCATIONAL ADMINISTRATORS

Illustrative of the short courses and inservice programs in educational quantitative analysis developed by educational administrators are Operation PEP (Preparing Educational Planners) and PDP (Professional Development Program). Both programs were directed primarily to inservice personnel. The emphasis of the two programs was on policy and planning problems rather than on tactical problems, and both stressed the development of analytical attitudes rather than specific operations research skills.

Operation PEP. Operation PEP, sponsored by the San Mateo County Board of Education, was an ESEA Title III project for preparing educational planners. The project produced twenty-four publications that covered the material presented in class dealing with educational management and systems techniques. The content of PEP seminars can be ascertained by reviewing the topics of the publications given to PEP participants:

accounting scheme for personality study

budgeting as a tool of allocation

budgeting in California intermediate and local education agencies

collective decision-making in organizations

digital computer principles

digital simulation and modeling

framework for the evolutionary development of an executive information system
- part 1: organizational problem-finding
- part 2: system design, implementation, and evolution

goals for public education in Texas

information system for a district school administrator

information system overview

input-output trends

manager's guide to objectives

network-based management procedures

organizational aspects of resource mobilization

persistent problems in system development

profile of cognitive development in children

social indicators, social reports, and social accounts—toward the management of society

state of the art in information handling

a system approach to planned change in education
part 1: an adaptive framework for public education and educational management
part 2: a strategy for planned change in public education

the role of system analysis in education management

The seminars were a full day long and usually met once or twice a month for a year and a half. They were primarily directed to school superintendents, school officials, and professors of school administration. Because the Operation PEP series emphasized qualitative or attitudinal methods, only simple quantitative methodologies, such as PERT and elementary linear programming, were discussed.

PDP. The Professional Development Program "PPBS Road Show" was jointly sponsored by the Association of California School Administrators, the California School Boards Association, and the California Advisory Commission on School District Budgeting and Accounting. During April and May of 1972, the program presented one-day workshops at eight different locations in California. These workshops were directed primarily to inservice personnel. However, participants also included preservice personnel, professors of education, and concerned citizens. The four sections of the workshop are described below.

Section 1—HOW TO INVOLVE PEOPLE IN DETERMINING WHAT THE PUPIL SHOULD LEARN: NEEDS, GOALS, OBJECTIVES, PRIORITIES

A. Participants will outline one process for involving the community in determining an educational philosophy and district goals.

B. Participants will describe one method of conducting a needs assessment.

C. Participants will develop one technique for identifying priorities.

D. Participants will develop one technique for involving the staff in defining program goals and objectives.

E. Participants will demonstrate an understanding of the technique for developing goals and objectives by writing two levels of goals, and two programs or instructional objectives.

Section 2—HOW TO DESIGN A PROGRAM STRUCTURE, DEVELOP A PROGRAM DESCRIPTION AT LEVELS IV AND V, IDENTIFY REQUIRED RESOURCES, AND DEVELOP ALTERNATIVE WAYS TO IMPLEMENT THE PROGRAM

A. Participants will design a tentative program structure to fit the unique characteristics and needs of their respective districts and be compatible with the state model.

B. Participants will write a program description for a program at level IV and a program at level V, assign responsibility, identify required resources, and state evaluation criteria.

C. Participants will develop one goal and one objective for each of the programs at level IV and level V.

D. Participants will develop two alternative ways to implement the program and achieve its objectives.

Section 3—HOW TO BUILD A PROGRAM BUDGET, WITH ATTENTION TO THE ALLOCATION OF RESOURCES, COST ACCOUNTING, AND THE COLLECTION AND USE OF DATA

A. Participants will develop a form for presenting the budget of an Instructional Program and a Support Program to the Board of Education.

B. Participants will develop two methods of allocating support costs to instructional programs.

C. Participants will develop a program budget cycle, identifying the necessary activities, and budget documents.

D. Participants will prepare a Multi-Year Cost Data Sheet for each of the alternatives, if time permits.

Section 4—HOW TO IMPLEMENT PPBS IN YOUR DISTRICT, LISTING TASKS TO BE ACCOMPLISHED, DEVELOPING A CALENDAR, IDENTIFYING CONSTRAINTS, PROVIDING TRAINING FOR STAFF, AND AVOIDING PITFALLS

A. Participants will sketch a rough draft of an implementation calendar, including all the elements and activities necessary to implement PPBS, consistent with the capabilities of their respective districts.

B. Participants will identify constraints, evaluate the status, identify required training and the time period necessary for accomplishing tasks.

C. Participants will identify the objectives of each task, as well as personnel and materials required.

D. Participants will list four benefits of systematic planning for effective accomplishment of implementation tasks.

Thus the PDP program was oriented to policy and planning and presented almost no training in operations research skills. This program did perform an adequate job of encouraging school administrators to view their educational programs and objectives in a systematic fashion and to explore the process of planning. Furthermore, it introduced much of the terminology used in the policy and planning area of educational quantitative analysis.

EDUCATIONAL CONSULTANTS

Programs developed by Research for Better Schools, Incorporated (RBS) and by the Battelle Corporation are representative of efforts by educational consultants to train school administrators in

quantitative analysis. Both of these organizations' programs focus on policy and planning problems and emphasize analytical attitudes rather than operations research skills.

RBS. Research for Better Schools, Incorporated, based in Philadelphia, is a nonprofit corporation oriented toward applied research and analysis. The purpose of this corporation, which receives government funding, is to see that important conclusions and policy recommendations of research and analysis in education are implemented in the schools.

For several years, RBS has worked cooperatively with two Pennsylvania school districts (the Radnor Township and the Harrisburg City schools). Among the stipulations in the agreement between RBS and the two school districts is one requiring RBS to teach certain planning and management skills to the administrative staffs of the two districts.

According to Stan Temkin, director of the RBS program Planning for Change,

> Our primary emphasis has been on implementing "comprehensive planning" by a bottom-up implementation strategy. We involve teachers heavily in a "year no. 1" (as well as administrators) in developing planning objectives and performance indicators. In year no. 2 those teachers who elect to be involved use the performance indicators in their classroom. At the end of year no. 2 teachers assess their weaknesses and school principals recommend, to the extent that they see the need, change. Recommendations are supported by cost estimates and coordinated at the district level. We have trained nearly 200 teachers and administrators and have involved more than 100 other teachers in these efforts.
>
> We are also producing self-instructional materials that are being tested in three other school districts. The purpose of the self-instructional materials is to allow RBS to have many districts engage in comprehensive planning without direct involvement by the RBS staff.

Working in close cooperation with the school districts, RBS has produced the self-instructional Comprehensive Planning Manual for Curriculum-Oriented Personnel. The instructional materials do not emphasize operations research skills. Instead, they outline to administrators and teachers some of the qualitative aspects of planning and policy-making. Hence, this program also is geared to instruction in the process of planning and policy-making and to acquainting participants with relevant terminology.

Battelle. Battelle is a private corporation based in Ohio with

offices worldwide. It is concerned with quantitative analysis and management primarily in the social sector.

The corporation's Center for Improved Education has developed a one-week workshop on planning for school administrators. This workshop combines the scientific and the human dimensions of education in a humanistic educational model. The workshop's primary goal is to prepare its participants (superintendents, assistant superintendents, board members, and others involved in local district planning and policy-making) to apply the humanistic model in a manner that will bring about constructive educational change in their school districts.

The topics of the Battelle lectures and discussions are listed below.

I. The Present Situation in Education
II. A Humanistic Philosophy of Education
III. The Nature of Man
IV. The Effective Human Being
V. Goals for a Humanistic School System
VI. A Humanistic Instructional Model
VII. Humanistic Educational Management
VIII. A Strategy for Educational Change

In addition, the workshop includes

1. A comprehensive laboratory exercise involving the workshop participants in
   - identifying educational needs
   - establishing priorities
   - specifying objectives
   - developing alternative solutions
   - formulating recommendations for action
2. A case history of an innovative middle school—from its inception to its present state.

The Battelle program is almost entirely humanistically oriented, though the workshops do concern themselves with some of the processes of planning and policy-making.

In summary, these two corporations have developed materials that might be considered primarily process oriented rather than skills oriented. Their programs focus on policy and planning problems rather than on tactical problems. Changes in attitudes and acquisition of knowledge are the primary intents of these efforts rather than development of operations research skills.

RESEARCH AND DEVELOPMENT CENTERS

The programs developed by research and development centers are by far the most comprehensive of all the inservice programs described here. They deal with both tactical and policy and planning problems, and they stress both the process of planning and policy analysis as well as the skills of operations research. Efforts representative of this approach have been undertaken by the Research and Development Division of the Center for Educational Policy and Management (CEPM) and the RAND Corporation.

Center for Educational Policy and Management. Newly formed on July 1, 1973, at the University of Oregon, the center consolidates in one organization the Center for the Advanced Study of Educational Administration (CASEA), the ERIC Clearinghouse on Educational Management, and two departments in the College of Education.

The programs that collectively are called the Research and Development Division are former CASEA programs funded largely through separate contracts with the National Institute of Education. Together, these programs concentrate on improving organizational and administrative practices in schools and helping administrators and other school people discover ways of implementing the emerging and most promising practices and products.

One of the Research and Development Division's programs is of particular interest with regard to inservice training and quantitative analysis. This program, PPBS in Schools—Organizational and Client Consequences, is seeking to determine the consequences—with respect to both organizational variables and client (student) interests—of implementing systematic program planning and budgeting systems (PPBS) in schools. SPECS (School Planning, Evaluation, and Communication System), a version of PPBS developed at CASEA between 1969 and 1972, is the form of PPBS that the program is implementing and studying.

SPECS is designed to systematize efforts within an organization to plan, allocate resources, implement, and evaluate its ongoing programs. Five components of SPECS help a school district develop certain capabilities. The components include

- a systems analysis of the school district
- program cost-accounting and budgeting
- program planning, implementation, and evaluation

- community-based broad goal definition
- assessing achievement of the district's broad goals

The SPECS researchers have developed a wide range of instructional materials. Some are for actual use in the district; others are aids for consultants. Some of the critical documents used in SPECS are the following:

> TDCAM (Total Direct Cost Activity Matrix)—a two dimensional chart that displays a district's ongoing activities, or "operating programs," on one dimension and its object-cost categories on the other dimension. The particular programs and categories are determined by the school district.
>
> PPED (Program Planning and Evaluation Document)—operationalizes (for training purposes only) the model of planning and evaluation that undergirds SPECS. It is used only to introduce the model and the cycle of program planning, evaluation, and replanning.
>
> PED (Planning and Evaluation Document)—designed for actual use in planning and evaluating the instructional units that institute an ongoing instructional program. It includes the "Record of Student Performance," a kind of grade book for "tracking" actual outcomes of an instructional unit or program, and the Program Summary.
>
> The SPECS Program Summary also is designed for actual use. It summarizes the most critical data in the multiple PEDs developed for units in a single instructional program.

The SPECS instructional materials have been field-tested in over twenty instructional settings and in an extensive three-year pilot-test intervention in one locale in particular. During the next five years, as the program shifts from a developmental interest in SPECS to a research interest, the program's strategy for implementation will change. Rather than replicating previous field-test experiences, General Learning Corporation, the publisher of all SPECS materials, will now be responsible for implementation. The Research and Development Division's responsibility will be to study the effects of those implementations.

Thus the division's approach is to develop and assess the impact of instructional training packages that can be used in school district inservice programs.

RAND. Formerly the primary focus of RAND research was on military projects funded by the United States Air Force. Now The RAND Corporation is expanding its research efforts (and funding sources) into many nonmilitary areas, including education. One of these efforts is the development of an educational policies center

at the RAND site in Santa Monica, California.

The purpose of one part of the center will be to familiarize school district planners and administrators with modern approaches to management and decision-making. (The other part of the center is to be a graduate institute in public policy.) The program is being designed to give the participants an understanding of (1) the fundamental concepts, principles, and procedures involved in the systems approach, (2) the range of analytic and management techniques available and their specific applications—and potential misapplications—in education, and (3) the relevant research on educational effectiveness being conducted at RAND and elsewhere.

According to the description found in a RAND grant proposal to the Carnegie Corporation, the training program is to be divided into two parts. The first part is a one-week intensive course on the systems approach to educational planning. This course is designed as an integrated whole, not as a series of discrete presentations by experts. While a lecture format is used for presentation of some of the material, considerable reliance is placed on other methods that are more successful in encouraging active participation of the trainees: seminars, case studies, exercise, and workshops.

The following is a tentative list of topics to be presented in the course:

1. *Understanding the Systems Approach to Educational Planning*
   - Role of Analysis in Educational Decision-Making (Lecture)
   - Organizational Aspects and the Political Context (Seminar)
   - Basic Features of the Systems Approach—An Analytical Primer (Lecture)
   - The Systems Approach in Education (Case Study)
2. *Phase One: Defining the Problem*
   - Plotting Future Direction (Workshop Using the Delphi Technique to Develop a Consensus of Opinion)
   - Generation of Alternatives (Exercise)
   - How to Ask the Right Questions (Seminar)
3. *Phase Two: Evaluation of Alternatives*
   - Conceptual Basis for the Evaluation of Educational Alternatives (Lecture with Examples)
     - Economic Feasibility: The Analysis of Costs and Effectiveness
     - Operational Feasibility: Problems of Implementation
     - Political Feasibility: Problems of Acceptance
     - Distributional Effects: Who Benefits? Who Pays? When?
   - Preparation of an Issue Paper (Exercise)

4. *Applying Analysis in Educational Planning and Administration*
   - The Range of Analytical Techniques Available, with Illustrations of their Use and Abuse (Lecture and Discussion)
   - The Use of the Systems Approach in Education (Case Studies)
     - Evaluation of Standard and Innovative Programs
     - Educational Resource Management via Program Budgeting
     - Evaluation of Performance Contracting
5. *Achieving an Effective Analytical Capability*
   - Development of Staff (Lecture)
   - Use of Outside Consultants (Exercise)
   - Organizing for Analysis (Lecture)
   - Use of Computers (Lecture)
   - Developing an Understanding of Analysis in the School and Community (Seminar)

The second part is made up of six two-day topical workshops at one-month intervals following the course. These workshops will consist of a half-day of lectures followed by a day and a half of working sessions during which participants work either on exercises planned by RAND or on designing approaches to equivalent problems in their own districts. The topics to be covered in the first six workshops are as follows:

- Performance Contracting
- PPBS–Educational Resource Management
- Instructional Media
- Educational Information Systems
- Quantitative Techniques in Educational Planning
- Educational Cost Effectiveness and Accountability

The aim of the training program is to improve management throughout school districts, not just the skills of a limited number of specialists. RAND has also developed a function training matrix, shown in table 10, in which basic tools and concepts of management science are crossed with various school district functions.

The proposed RAND program focuses on both tactical and policy issues. It is intended to train practicing school administrators in the skills of operations research as well as in the processes of planning and policy-making. Of all the inservice programs, RAND's most closely parallels a university-based program in educational quantitative analysis.

In summary, research and development organizations are making serious efforts to update the quantitative and managerial skills of

TABLE 10

RAND FUNCTION TRAINING MATRIX

	Basic Concepts			*Basic Tools*					*Information System Orientation*	*Integrating Workshops*
	Systems Analysis	Planning Programming and Budgeting	Accountability	Statistical Analysis	Modeling	Resource Analysis	Effectiveness Analysis	Evaluation/ Research		
Planning and research										
Establish goals and objectives		x	x						x	x
Design alternative programs	x	x							x	x
Select programs	x	x		x	x	x	x		x	x
Establish performance criteria		x	x						x	x
Develop budget		x						x	x	x
Identify points of accountability		x	x	x				x	x	x
Establish evaluation strategy		x							x	x
Allocate resources	x	x		x	x	x	x			
Administration										
Monitor educational outcomes	x	x	x	x			x	x	x	x
Monitor expenditures	x	x	x	x		x		x	x	x
Allocate discretionary resources	x	x		x	x	x	x		x	x
Report progress to public	x	x	x						x	x
Report average daily attendance									x	
Allocate maintenance resources	x	x		x	x	x	x		x	x
Instruction										
Establish instructional strategy		x	x		x	x	x		x	x
Evaluate educational progress		x	x	x		x	x		x	x
Counseling										
Determine cause of referral									x	
Counsel students			x						x	

school district personnel. These programs offer comprehensive training in the tools and techniques of quantitative analysis. Compared to other inservice programs, the RAND effort is by far the most formal, rigorous, and comprehensive and is well integrated with other social science fields.

Both the CASEA and the RAND programs are in the developmental or proposal stage, so it is difficult to ascertain their impact. It appears that they are aimed at the right population (practicing school administrators), but the ultimate success of these efforts rests on the quality of their instructional packages.

SCHOLARLY ORGANIZATIONS

It has been noted that university programs are aimed primarily at preservice personnel while the other programs are geared primarily to inservice personnel. Unlike these programs, instructional efforts sponsored by scholarly organizations are not directed to one of these groups in particular. The Phi Delta Kappa program is intended primarily for practicing administrators; the primary focus of the American Educational Research Association (AERA) program is on the researcher in educational quantitative analysis; and the UCEA program is aimed primarily at professors of school administration.

Phi Delta Kappa. The Phi Delta Kappa-sponsored program was developed by the Program Development Center of Northern California (Butte County Schools Office) through a Title III ESEA grant from the Office of Education.

> [The program] provides for the involvement of members of the community, professional staff and students in: ranking educational goals in order of importance; determining how well schools' current programs meet ranked goals; [and] developing performance objectives to meet ranked goals. (Phi Delta Kappa, n.d.)

This is one of the few programs that specifically focuses on incorporating students and community members into the goal-setting process. The program is a kit (available for $60.00*) that includes an administrative manual, programmed inservice workbooks, goals-ranking and needs-assessment material for staff and community meetings, and suggested media releases, letters, and data-reporting procedures. Consultant assistance is also available.

*Available from Dr. B. Keith Rose, Program Development Center of Northern California, Chico State College, Chico, CA 95926.

AERA. The AERA Division of Administrative Studies sponsored a four-day presession on operations research-systems analysis prior to the 1971 AERA annual meeting in New York.

The presession was attended by approximately fifty school officials, researchers, and professors of educational administration. It was directed at personnel interested in the application of management science and operations research models to problems in education. Accordingly, the daily meetings and nightly laboratory and problem sessions were devoted not only to the theories and techniques necessary for improving resource allocation and school activity planning, but also to explaining a number of recent successful applications of these methods. The session stressed the utility and limitations of models designed to effect changes in and, hence, to improve educational planning and administrative practices.

The chief objectives of the presession, as listed in the course description, were as follows:

1. to provide a method of assessing the value of operations analysis to operational and resource allocation problems in elementary and secondary education
2. to provide the necessary computer and mathematical techniques to appreciate and understand operations analysis and systems approaches to educational planning and administration
3. to disseminate up-to-date findings in the applications of operations analysis to education

The following topics were covered in the presession:

- *Nature and Philosophy of Operations Analysis*
- *Review of Mathematical and Computer Techniques*
- *Mathematical Techniques and Operations Analysis*
  - I. Input-Output Analysis
  - II. Linear Programming Models
    On-line computer interaction and voluntary workshop
  - III. Queuing Models
  - IV. Microeconomic Theory and Econometric Models of Education
- *Applications*
  - I. Teacher Salary Schedules Models
  - II. Modeling School Attendance Areas
  - III. Application of Mathematical Programming to Voc-Ed Planning
  - IV. Application of Mathematical Programming to School Finance
  - V. Application of Mathematical Programming to Evaluation of Instruction

VI. Monte Carlo Techniques for Determining Size of Substitute Teacher Pools

On-line computer interaction and voluntary workshop and bookshelf study

- *Information Systems for Planning and Evaluation*

  Information Systems at the

  (i) Single Elementary or Secondary School
  (ii) School District Level
  (iii) State Level

- *Simulation Techniques*

UCEA. UCEA is currently engaged in producing instructional and teaching materials for educational quantitative analysis. These materials are geared specifically to the needs of professors of school administration at universities that are members of UCEA. A conference planned for May 1973 will formalize plans for the development and dissemination of this information.

In summary, scholarly organizations to date have had but a small impact in the field of educational quantitative analysis. Their primary potential seems to lie in being vehicles for updating skills, attitudes, and knowledge, particularly of professors and researchers. Thus, scholarly organizations should be encouraged in their dissemination of knowledge about educational quantitative analysis to researchers and professors in educational administration.

5

Conclusion

The increasing demand for accountability and school-site decision-making has placed new pressures on school administrators. At the same time, developments in the tools and techniques of quantitative analysis have provided administrators with increased potential to cope with these pressures. Interest in the application of quantitative analysis to school problems, demonstrated on international, federal, and professional levels, has been documented in this monograph.

SUMMARY

After reviewing the interest in quantitative analysis and defining its terms, two rationales for incorporating it into school administrator preparation programs were discussed. First, the role of the school administrator is changing from that of a humanistic team leader to that of a management-oriented decision-maker. Quantitative analysis can aid the administrator in his new role in many

ways, improving the quality of his decisions as well as providing him with more working time. Second, the specialist in educational quantitative analysis can be a valuable member of the educational administrative team. He can assist in solving operations research-type problems, in establishing a spirit of inquiry, and in articulating school district plans and policies to the community.

However, the application of quantitative analysis methods in the schools is by no means a simple and straightforward process. Both practical and theoretical problems must be dealt with. Practical problems include the complexity and confusion associated with quantitative analysis and the fact that its promise often exceeds its results. Also, quantitative analysis is often biased toward quantifiable data. Finally, this kind of analysis is often expensive, making it more readily available to rich districts than to poor ones.

Additional practical problems center around the role of the quantitative analyst. Often because of his technical expertise he is considered an expert in other areas and is called on to deliver expert advice when he is not prepared to do so. It is essential that the role of the quantitative analyst be clearly defined and that the administrator's expectations of the analyst's services be kept in bounds.

The theoretical issues center around the question, "Can the schools be viewed as factories?" As noted above, production theory is far more developed than educational theory. Moreover, much difficulty exists in defining and identifying both the inputs and the outputs of the educational process.

Having established the need for quantitative analysis and discussed the problems and issues involved, a hypothetical program for preparing educational administrators in quantitative analysis was presented. Such a preparation program should be designed to serve three distinct groups: general administrators, practicing specialists, and researchers. The general administrator should be trained to appreciate and utilize the results of quantitative analysis. He should be thoroughly acquainted with both its potential and its limitations. The specialist should be trained to formulate quantitative analyses and to articulate their results. And the researcher should be prepared to bridge the gap between theory and practice.

Based on this background, several representative programs already in practice were described. These programs are sponsored

by several sources including colleges and universities, practicing administrators, research and development centers, and scholarly organizations.

FUTURE DIRECTIONS

In 1967, the chairman of the AERA Committee on Educational Organization, Administration, and Finance observed: "There seems to be a growing tendency to assume that administrative procedures, instructional approaches, schools, and fiscal structures must be analyzed as *systems* or systems components" (Erickson 1967, p. 376). This trend has been projected into the present decade:

> School systems will see the advent of new staff specializations in the next five to ten years. . . . The new unit . . . may include computer and data processing experts, systems analysts, and operations researchers. . . . Problems that can be submitted to quantitative analysis will be increasingly solved using OR techniques. . . . Application of the systems approach will place greater emphasis on planning, thoughtful analysis, and increased information requirements. (Culbertson and others 1969, pp. 185-186)

INCREASING AWARENESS OF NEED

A review of the literature on school administration reveals several trends that relate to quantitative analysis. First, administrators are legitimizing their function in the schools by developing the values and skills of a managerial class. Second, this change from a team leader in the humanist tradition to a manager is requiring administrators to develop and refine their skills in analysis, especially quantitative analysis. Third, the management technologies and decision-related analysis are beginning to incorporate the quantitative skills most appropriate for a manager. Fourth, most educational research and practice are becoming more quantitative and decision-related.

It can be concluded from these trends that school administrators need background in and exposure to the techniques of quantitative analysis in addition to traditional statistical methodologies. This background and exposure is needed if administrators are to keep up with the literature, to perform adequately in their planning and decision-making tasks, and to evaluate and assess the utility of these techniques in specific planning situations. Educators "who

continue to pay little attention to redirecting their purposes and planning will simply be eliminated from consequential decisions if present trends toward . . . purposive redirection of educational institutions continue" (James 1969, p. 63).

This review of the state of the knowledge in practice indicates an increasing awareness of the need to prepare educational administrators in quantitative analysis. This awareness is evidenced by an increase in the number of formal university programs in the field as well as in the number of programs developed by educational administrators, educational consultants, research and development centers, and professional organizations.

PROBLEMS AND POTENTIALS

The problems associated with the limitations of quantitative analysis will continue to be evident in the 1970s.

> There will be improper adaptation of models developed elsewhere to educational situations, an overemphasis on the gathering of quantitative data through crude testing devices, and overemphasis on economic efficiency. It would also seem likely that because of the complexities involved in comprehensive analysis and lack of adequate data concerning educational outputs that extensive use of formal methods of analysis will be somewhat limited during the next five to ten years. There will be a quantitative increase in the use of the techniques, but formal analysis will be directed at new programs, middle range programs with similar objectives, programs where information is available or can be obtained at minimum cost, and programs where there is a clear relationship between input and output. However, even within these limitations a number of new trends associated with the use of management technologies may emerge that will affect educational organization and administration. (Culbertson and others 1969, p. 182)

It appears that as educational administrators become more proficient in the application of quantitative analysis, the scope and effectiveness of these tools and techniques will be dramatically increased. A primary limitation of educational quantitative analysis in the past has been that studies were often conducted by those who were insufficiently trained—either analysts who were not sufficiently acquainted with the specific problems associated with education or educators who were not sufficiently acquainted with quantitative analysis. It appears that the bridge between quantitative analysis and educational problems is becoming increasingly stronger. This closer relationship should result in analyses of higher quality

that, in turn, should generate increased confidence in the applicability of these tools and techniques.

THE GENERALIST AND THE SPECIALIST

The UCEA staff notes that "departments of educational administration in the 1970s will need to differentiate more sharply than in the past between and among programs for preparing researchers, synthesizers, developers, and educational administrators" (Culbertson and others 1969, p. III). In the field of quantitative analysis, programs should continue to be developed that differentiate among the general administrator, the quantitative specialist, and the researcher in educational quantitative analysis.

Over the past decade, both the complexity of the educational problems studied and the sophistication of the techniques utilized in their analysis have gradually increased. With the entrance of American education into the era of accountability, a large body of literature has developed that deals with the efficiency-related applications of mathematical methods to problems in educational planning. Several books have been written on this subject. Therefore, the principal task of those responsible for training future public school administrators will be to disseminate the insights and information found in these research studies and to ensure that comprehensive treatment of quantitative analysis is included as part of the curricula in graduate schools of education.

Quantitative analysis has great potential for aiding school administrators in their new decision-making tasks. Those responsible for administrator preparation programs can help this potential to be realized by developing programs designed to train knowledgeable general administrators, competent specialists, and imaginative researchers in the field of educational quantitative analysis.

Appendix

HARVARD UNIVERSITY

Doctoral study in educational planning is offered through the Center for Studies in Education and Development, which has been the base for the School of Education activities in education abroad. CSED began as a research center in 1962; since then its scope has been broadened to include doctoral study and overseas planning assistance, as well as research relating to education and development. It has also become increasingly concerned with planning problems in the United States.

The doctoral program is designed for men and women who seek careers in educational planning or in educational administration involving a major element of planning. Most students train for careers in ministries of education, regional offices of education, government planning organizations in developing countries, or national or international organizations concerned with education overseas. A small but growing number seek planning careers in national, state, or local urban educational offices in the United States. The following are courses in the Harvard sequence.

A-111 Introduction to Educational Planning Methods

Demographic, econometric, social statistical, mathematical, and historical methods and routines for schematizing human resource development. The course is designed for students in the educational planning program, for ACP administrators, and for those students in ESP for whom it is interesting and relevant. The course is designed as an introduction to working with the statistics of educational systems, populations, etc. Lectures and classroom demonstrations, workshop demonstrations, and the preparation of exercises are included. Students may receive half-course credit by taking any three of the four equal modules listed below:

. Education and Economic Development

Factors affecting economic development. Government policies for development. The role of education in economic development planning.

Educational Statistics and Projection

The use of projection methodologies in the development of plans and future strategies in educational systems. Covers futurology from a mathematical and statistical viewpoint and the use of computer routines in projection and simulation based on educational system statistics.

Research and Evaluation

Overview of research needs in educational planning and basic principles of survey research, experimental design, and evaluation research. Brief research and evaluation designs will be developed for analyzing educational problems.

Assessment and Measurement

Basic theory and practice of educational testing as it applies to the evaluation of educational systems.

A-58 Problems in Computer Applications in Educational Administration

Explores major issues and practical problems facing educational administrators in their efforts to apply computers in their work. Wherever possible, cases and field situations will provide the bases for analysis and discussion. Topics range from school data processing to administrative decision-making and include an introduction to computers and computer programming. No previous training in computers is assumed.

A-205 The Systems Approach and Educational Management

An intermediate course dealing with the use of models and techniques of systematic analysis to represent and resolve technical problems in educational management. Focus is on structure and technique, not on any particular level or type of education, domestic or foreign. Some affinity for mathematical and occupational work is desirable.

Introduction to the Economics of Education

Basic problems of microeconomics are presented with emphasis on their application to problems of education. (Special attention will be devoted to the analysis of costs, budgeting, and teachers' salary schedules, to allocation of resources to educational systems, and to problems of taxation and the financial support of public education by federal, state, and local levels of government.)

NEW YORK UNIVERSITY

New York University does not have curricula or course work in the general area of educational operations research per se, but does have one course in PPBS-systems analysis. Students go outside the department for operations research-type courses. The following is an outline of the PPBS course with a list of class lecture topics.

Planning-Programming-Budgeting Systems

I. The Systems Approach to Administration and Planning
(How is systems analysis a mode of thinking?)

II. The Evolution of Planning and Budgeting in Education
(How is PPBS a composite of earlier administrative reforms?)

III. Potential Misuses, Misconceptions, and Limitations re PPBS
(What pitfalls must be avoided in PPBS installation?)

IV. Characteristics, Advantages, and Components of PPBS
(What are the specific properties of a PPB system?)

V. Designing a Program Structure by Means of Levels
(What is the best way to develop a comprehensive program structure?)

VI. Refining a Program Structure
(How should program designs be adapted to particular schools?)

VII. Suggested Sequence for Installing PPBS in Your Organization
(How should an institution go about converting to PPBS?)

VIII. Converting Function-Object Budgets to Program Budgets
(How are both budget formats presented concurrently?)

IX. Preparing Objectives and Evaluating Performance
(How can desired outcomes and accomplishments be improved?)

X. Recent Projects Involving PPBS Installations
(What organizations are actually "doing" PPBS?)

XI. Curricular Implications of Program Budgeting
(What roles do instructional personnel play in a PPBS?)

XII. Fiscal Implications of Program Budgeting
(What types of budget codes, accounting procedures, and timetables are needed?)

XIII. Organizational Implications of Installing PPBS
(What is a desirable process for actual implementation?)

XIV. Organizing and Processing Data for a PPBS
(What are the data files of a management information system?)

STANFORD UNIVERSITY

Stanford University has a joint program in school administration with the Graduate School of Business. In the business school, the focus is on methodologies of OR with particular emphasis on mathematical programming included in the basic course, Bus. 261. The following is a description of course work.

Bus. 261 Operations and Systems Analysis I

The course attempts to develop a basic competence and judgment in using quantitative and mathematical methods to analyze decision-making problems. The particular focus is on linear optimization models using techniques of mathematical programming for their solution. (A number of applications of this technique in educational administration have recently been developed, such as balancing racially the enrollment in a school district among various schools, allocation of classroom space, financial resources allocation, etc.)

In addition, three courses in the School of Education have heavy content in the area of systems analysis and educational OR.

ED 313A Seminar on the Economics of Education

This two-quarter sequence is devoted to studying the increasing body of knowledge on the economic aspects of education and the application of tools of economic analysis to problems in education. Particular attention is devoted to: the production of education, e.g., estimation of produc-

tion functions for different kinds of schooling; the distribution of educational benefits, e.g., determining who receives the benefits of schooling; education as a social investment, e.g., assessing the role of education in economic growth; organization of the education industry, e.g., examining for efficiency implications the public-private mix of firms producing schooling; financing education, e.g., examining the present patterns of educational finance and several proposed innovations; innovation and evaluation, e.g., determining how the performance of the education industry can be judged.

Ed. 326A School Finance

The course covers the problems and principles involved in financing public schools. The course starts with a history of school finance followed by conceptual material on determining the optimal level of schooling output. How schools are paid for is the final topic and covers present methods, the development of better criteria, determination of aid patterns and patterns of taxation.

Ed. 326B School Finance

The course is a continuation of the previous course of the same name, taking up more specialized topics in the financing of public schools. Basic conceptual material on the economic "Theory of the Firm" is introduced, followed by concepts of educational production and cost-effectiveness analysis. Resource markets for schools with emphasis on teacher markets is explored. The final portion of the course is devoted to PPBS in education—discussion of concepts, costing principals, evaluation, feedback, and planning.

Finally, a joint seminar in school administration deals with issues and problems in school administration.

Joint Seminar in Educational Administration

This seminar is a two-quarter sequence which attempts to relate the learnings students have experienced at the business school in managing profit-making enterprises to the issues and problems of educational administration. For example, the seminar considers refinements in accounting procedures at various levels of education, the design of management information systems for education, mathematical allocation models applied to educational problems, developing evaluable educational goals, human issues in education administration, etc. This seminar was developed expressly for the joint program participants. Professor Michael W. Kirst of the School of Education administers the seminar, but the primary instructional resources are a professor from the business school and a professor from the education school who jointly supervise a session on one of the topics within their professional area.

UNIVERSITY OF CALIFORNIA, BERKELEY

The University of California at Berkeley has developed a two-course sequence in educational operations research, with the basic course enrolling 12-20 students and 6-10 students in the sequel course.

The following is a description of the introductory course Education 255C, Introduction to Systems Analysis in Education.

I. Introduction to General Systems Theory

II. Fundamental Ideas Underlying Models in Systems Theory

III. Static Models and Optimization Theory
IV. Modern Control Theory
V. Classical Control Theory
VI. Simulation Analysis
VII. Artificial Intelligence
VIII. Information Theory
IX. Game Theory
X. Network Theory
XI. Statistical Decision Theory
XII. Management Information Systems

The sequel course, Ed. 255D, deals exclusively with optimization techniques and cost-benefit analysis in education.

A description of all courses in the educational planning sequence follows.

255A Introduction to Educational Planning

One 3-hour lecture and one 1-hour conference per week. The concept of planning education. Principal techniques used. Model building and system analysis in education. Manpower, social demand and cost-benefit planning. Relationship between planning and administration. Planning at international, national, and regional levels.

255B Advanced Seminar in Educational Planning

One 3-hour lecture per week. Prerequisite: course 255A or consent of instructor. Measurements and statistics in planning. Qualitative vs. quantitative planning. Manpower analysis vs. the social demand approach. Case studies of educational planning in Europe, the United States, and in developing countries.

255C Introduction to Systems Analysis in Education

One 3-hour lecture and one 1-hour conference per week. Introduction to systems theory and its application in education. Optimization theory, control theory, computer simulation analysis, complex information theory, and others. Case studies in education. Particular attention given to application in school management.

255D Seminar in Systems Analysis in Education

One 3-hour lecture per week. Prerequisite: course 255C or consent of instructor. A study of optimization techniques and cost-benefit analysis applied to education problems.

255E Advanced Seminar in Systems Analysis in Education

One 3-hour lecture per week. Prerequisite: course 255D or consent of instructor. Topics in mathematical and computer modeling in education including modern control theory and computer simulation techniques.

UNIVERSITY OF FLORIDA

Two courses are offered at the University of Florida in educational operations research. These are EDA 640 and EDA 641. They are described below.

EDA 640 Utilization of Computer in Educational Administration

Introduction to man-machine systems. Special emphasis on EDP and the school administrator; select administrative computer applications

such as salary analysis, enrollment projections, computer simulation, and PERT; integrated information systems, and implications for the future.

Course Outline

I. Introduction (Basic Concepts and Terminology)
   A. Historical Perspective
   B. C.P.U. Configuration
   C. Hardware (unit record equipment & C.P.U.)
   D. Card layout and coding of data
   E. Flowcharting
   F. Software (Programming)
   G. Planning and Implementation

II. EDP and the School Administrator (Applications)
   A. Pupil personnel (census and student records, grade and attendance reporting, registration and scheduling, test scoring and reporting, counseling and guidance, etc.)
   B. Business (staff personnel, payroll, financial reports, school stores, etc.)
   C. Institutional (simulation) (salary, enrollment, transportation, school lunch, PERT, computer graphics, etc.)
   D. Instructional (CAI, test scorings, problem-solving, etc.)
   E. Research and development (Statistical—BMD and SPSS)

III. Integrated Information Systems
   A. Data Bases, Input and Output
   B. Education Subsystem Classification
   C. Information Service Centers
   D. Organizational Responsibilities
   E. Reorganization of Administrative Structure

IV. Implications for the Future
   A. New Data-Processing Concepts
   B. Future Development
   C. Preparation of Educators

EDA 641 Systems Management in Educational Administration

Prerequisite: EDA 640 and basic course in statistics
Introduction to systems management and the interrelated elements making up the systems management approach. Also, special emphasis on select quantitative systems techniques on utility analysis, decision theory, game theory, linear programming, and simulation and modeling.

Course Outline

I. Systems Management in Educational Administration (Concepts, Terminology, and Interrelated Elements)
   A. Systems Analysis: Definition, Past Development and Present Problems
   B. Input/Output Analysis
   C. Information Systems
   D. PPBS
   E. Simulation and Modeling
   F. Accountability (the Production Function)

G. Cost-Effectiveness and Process Evaluation
H. Performance Contracting

II. Quantitative Systems Techniques (Applications)
A. Utility/Cost Analysis
B. Decision Theory
C. Graph Theory
D. Game Theory
E. Network Analysis
F. Inventory Models
G. Markov Chains
H. Queuing Theory
I. Linear Programming

UNIVERSITY OF GEORGIA

The University of Georgia has developed two courses, taught in the department of educational administration, related to educational operations research. These are EAS 919 (Planning for Education) and EAS 908 (Simulation and Decision-Making in Education). The average student enrollments in these courses are 7 and 32 respectively. The course EAS 908 has been in the program for five years with only recent emphasis on systems analysis and operations research. EAS 919 was organized three years ago. The following is a topic outline for EAS 919.

EAS 919 Planning for Education

Part I—Educational Planning Theory

I. The Role of Planning in Educational Administration
II. A Theoretical Basis of Planning
III. The Planning Process
A. The Scientific Method
B. The Descriptive Survey
1. General Nature
2. General Procedures
3. Types of Surveys
C. The Systems Approach
1. Definitions
2. Systems Theory
3. Systems Analysis
IV. Planning Roles and Group Processes
V. Strategies in Planning
A. Program Evaluation Review Technique (PERT)
B. Critical Path Method
C. Planning Models
D. The Delphi Technique
E. Decision Tables
F. Least Squares Method
G. Forecasting and Projecting
VI. Critical Dimensions of Planning
VII. Relationships to Public Planning Agencies
VIII. Master Plan for Education

Part II—The Comprehensive Educational Survey

IX. The Comprehensive Survey Approach
X. Community Analysis
XI. Educational Program Analysis
XII. School Population Analysis
XIII. School Business Services
XIV. Administrative Services
XV. Fiscal Analysis
XVI. The School Plant
XVII. Formulating Conclusions and Recommending a Plan of Action
XVIII. The Survey Report

Part III—PPBES

XIX Planning-Programming-Budgeting-Evaluation Systems
A. Planning—Setting Goals and Projecting Needs
B. Programming—Preparing Objectives and Developing Strategies
C. Budgeting—Relating Finances to Program Plans
D. Evaluating—Analyzing Costs and Effectiveness

EAS 908 Simulation and Decision-Making in Education

The sequel course has the following activities designed to affect achievement by students in two major areas:

A. Identifying and delineating problems that are appropriate for decisions
B. Designing educational information-decision systems and, further, identifying means for implementing the systems

For area A, the student will be required to demonstrate competencies in each of the following:

1. writing and applying operational definitions
2. using and applying a language of logic
3. identifying organizational tasks and making these tasks problematic
4. identifying problems that relate to the achievement of the organizational tasks
5. delineation of problems

Area B is separated into six subareas for convenience in organizing activities and for student assessment. The students must demonstrate competencies by satisfactory achievement of several criteria for each of the six subareas. These areas—the components of an information-decision system—along with descriptions of the criteria for achievement, are further delineated below.

1. The publics that relate to the educational organization.
2. The objectives of the publics that relate to the educational organization.
3. The informational needs of the publics.
4. Data processing.
5. Decisions.
6. Research and evaluation.

UNIVERSITY OF ILLINOIS

The University of Illinois presently has one course dealing with educational operations research, Educ. Admin. 462. The following is a course description:

Educational Administration 462 Educational Business Administration

Course Abstract. Structure and operation of educational systems considered from social, economic, and political perspectives at macro- and micro-levels. Covers the functional and systemic structure of the business administration component of complex educational organizations; the analysis, operation, and evaluation of educational management systems, procedures, and techniques; and the conceptualization of long-range planning, resource allocation, and systems approaches.

Course Outline

I. Organization of Education
   A. General Systems Theory
      1. Models of analysis
      2. Distinct from systems approaches
      3. Cybernetic society
   B. Economics of Education
      1. External or spillover effects
      2. Educational production function
      3. Internal efficiencies
   C. Sociopolitical Aspects
      1. An adaptive, open system
      2. National system of education
      3. Legal and extralegal relationships
   D. Educational Planning
      1. State of the art

II. Public School Finance
   A. Existing finance schema
      1. Federal, state, and local resources
      2. Common school support in Illinois
   B. Critique of Existing and Proposed Finance Plans
      1. Equality of opportunity
      2. Trends toward reorganization

UNIVERSITY OF MISSOURI

The University of Missouri has one course in the area of educational OR that is integrated with the school of business administration course in OR. A description of the course was not available.

UNIVERSITY OF TENNESSEE

The University of Tennessee has developed a course in educational OR titled, Introduction to Educational Planning.

E.A. & S. 5530 Introduction to Educational Planning. (3)

An introduction to the scope and content of selected educational planning and decision-making procedures.

Purposes

One purpose of this course is to introduce the educational administrator to the scope and specific content of selected educational planning procedures. Educational planning theory paralleled by introductory concepts appropriate for decision-making are an integral part of this course. This course also deals with a systems approach to accountability, selected planning models, and educational program cost-effectiveness analysis.

Major Topics

I. Educational Planning
   A. The Need in Educational Administration
   B. Technology and Intellectual Systems
   C. A Brief History of Systems Analysis
   D. Recent Developments in Systems Analysis

II. Educational Systems Theory
   A. Types of Administrative Decisions
   B. Decision Methods
   C. Decision-Making and Program Objectives
   D. The Decision-Maker's Objectives

III. Program Output Evaluation
   A. Behavioral Objectives
   B. Preference Assignment
   C. Integration of Assigned Values and Degree of Behavioral Objectives Achieved

IV. Program Decision Models
   A. Program Cost Analysis
   B. Conditional Worth
   C. Conditional Opportunity Loss
   D. Expected Opportunity Loss

V. Cost-Effectiveness Analysis
   A. Effectiveness and Cost
   B. Program Structure
   C. An Example of Program Cost-Effectiveness Analysis
   D. Major Pitfalls

VI. A Case Study of Traditional Cost-Effectiveness and Expected Opportunity Loss
   A. Preference Assignment
   B. Expected Opportunity Loss
   C. Traditional Opportunity Loss
   D. Traditional Cost-Effectiveness Analysis
   E. A Comparison

UNIVERSITY OF UTAH

The University of Utah has one course in management science-operations research for school administrators. The following is a description of the course.

Educational Administration 633 R Planning and Management Systems Applied to Education

Course Outline

I. Comprehensive Planning in Education
   A. Rationale for Comprehensive Planning and for Management

Procedures in Education
B. An Overview of Systematic Approaches to Planning and Management: Systems Analysis, Operational Analysis, PPBS, PERT, etc.

II. Systems Analysis—a Systematic Approach to Educational Problem-Solving and Decision-Making
A. Concept of Logical Problem-Solving
B. Concept of Systems and Systems Analysis
C. Introduction to the Processes (Tools and Steps) of Systems Analysis

III. Systems Analysis (continued)
A. Mission Analysis in Education
B. Functional Analysis in Education
C. Task Analysis in Education

IV. Systems Analysis (continued)
A. Method–Means Analysis
B. Steps and Tools of the System Synthesis Process in Education

V. Student Applications of Systems Analysis to Problems in Education

VI. Program Evaluation and Review Technique (PERT)
A. An Overview (film)
B. Management Concepts and Principles
C. Planning Concepts and Principles
D. Planning Networks
E. Network Development

VII. PERT (continued)
A. Time Estimating in Network Analysis

VIII. PERT (continued)
A. Progress Control—Management Review
B. PERT/COST—Planning for Cost

IX. Student Applications of PERT to Educational Projects

X. Culminating Activities

UNIVERSITY OF WISCONSIN, MADISON

The University of Wisconsin has developed two courses dealing with educational operations research. These are Educational Administration 305-825 (Administration of Research and Development Activities in School Systems) and a new course dealing specifically with educational OR. The department also has other courses that cover the management science-operations research area. These courses are as follows:

Computer Applications to Educational Administration
Business Administration of School Systems
Supervision as Systems Analysis
Educational Planning in the Urban Regional Context
Program Budgeting in Education

The major areas of study for administration of research and development activities are as follows:

I. Agencies Involved in Research and Development

II. Organization of Research and Development Agencies
  A. General Organizational Patterns
  B. Patterns in Public School Systems
III. Managing the Research and Development Operation
  A. Staffing and Internal Operations
  B. Management Tools
  C. Evaluation
  D. Proposal Preparations and Funding
IV. Utilizing Results of Research and Development Activities
  A. Dissemination Strategies
  B. Methods and Media

The course developed in 1972 specifically related to educational operations research will include linear programming, PERT/CPM, queuing theory, multiple regression, and decision rules. The course has as a prerequisite the course in computer applications and a course in elementary statistics.

Ed. Administration 760 (Computer Applications to Educational Administration)

The purpose of this course is to provide a basic introduction to computers for educational administration. The course will contain two central themes:

1. Lecture and reading relevant to the day's topic (large group)
2. Laboratory experience in the preparation of data for specific computer application and subsequent interpretation of output

The laboratory sessions will be devoted to the development and coding of data for specific "canned" programs in the following areas:

1. School enrollment projections
2. Salary analysis
3. PERT

Course Outline

I. Introduction to Course/Course Requirements/Introduction to Computing
II. Key Punching
III. Enrollment Projections
IV. Key Punching with Drum Control/Unit Record Equipment/Introduction to Salary Schedule Analysis
V. Student Scheduling and Grade Reporting
VI. Salary Schedule Analysis
VII. Salary Schedule Analysis
VIII. Introduction to PERT and CPM
IX. PERT and CPM
X. Organizing Data for Research
XI. Introduction to Statistical Computing/FORMAT Specifications
XII. Program DISTX
XIII. Computing in Higher Education
XIV. Strategies of Organization for Data Processing
XV. Automatic Mapping of Geographic Variables

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